SCIENCE

VOL. 91 FRIDAY, JANUARY 5, 1940 No. 2349

The American Association for the Advancement of Science:
Research and Invention in Engineering Colleges: DR. A. A. POTTER 1

Physiological Alterations as the Cause of Senile Debility and Senile Mortality: DR. HENRY S. SIMMS 7

Obituary:
Leta S. Hollingworth: PROFESSOR ARTHUR I. GATES. *Recent Deaths and Memorials* 9

Scientific Events:
Occurrence of a Deposit of Trona; The Finances of the American Chemical Society; The Permanent Science Fund of the American Academy of Arts and Sciences; The Western Society of Naturalists; The Prize of the American Association 11

Scientific Notes and News 14

Discussion:
The Distribution of Poliomyelitis in Louisiana: DR. ALBERT E. CASEY and BRANCH J. AYMOND. *A Theory of Protein Metabolism:* PROFESSOR CARL L. A. SCHMIDT, PROFESSOR FRANK WORTHINGTON ALLEN and DR. HAROLD TARVER. *The Treatment of Extreme Cases of "Sniffles" in the Rat with Sulfapyridine:* FRED Y. BILLINGSLEA. *Soviet Cosmology:* ASTRONOMER 17

Special Articles:
Immunity to Experimental Pneumococcal Infection with an Artificial Antigen Containing a Saccharide of Synthetic Origin: DR. WALTHER F. GOEBEL. *The Determination of the Total D-Amino Acid Content of Human Tumors and Normal Tissues by Means of D-Amino Acid Oxidase:* DR. FRITZ LIPMANN and OTHERS 20

Scientific Apparatus and Laboratory Methods:
A Simple Method to Use in Recovering Feces at Measured Intervals: KENTON L. HARRIS. *Indexing and Filing Scientific Photographs:* DR. JOSEPH M. TREFETHEN 23

Index to Volume XC i

Science News 10

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

RESEARCH AND INVENTION IN ENGINEERING COLLEGES[1]

By Dr. A. A. POTTER

DEAN OF ENGINEERING, PURDUE UNIVERSITY

RESEARCH AT ENGINEERING COLLEGES

THE practice of engineering can only be kept up to date through research. Engineering research has among its major objectives the development by scientific means of new manufactured products, more efficient machines and tools, special mechanisms and devices, improved meters and instruments, better manufacturing processes and more economical methods of operating equipment. Industries that have made the most spectacular progress are also foremost in research. Research is an integral part of any organization interested in efficiency, in long-range goals and in linking the present with the future.

[1] Address of the vice-president and chairman of the Section on Engineering, American Association for the Advancement of Science, Columbus, Ohio, December 28, 1939.

No very clear-cut line can be drawn between scientific and engineering research, although the latter is more generally concerned with the results of immediate economic value. It is also difficult to differentiate between research and development.

Research in higher educational institutions is being supported to a considerable extent by industry and government. Industry recognizes that the research specialist at an educational institution is working in an atmosphere which is sympathetic to research and free from interruptions. The efforts of the research worker in an educational institution result not only in new knowledge but also in improving the main product of education—the students. In the past there has always existed a definite gap between the successful completion of a scientific research project and the utilization by industry of the results secured.

This gap is being greatly reduced by cooperative research, which brings together most effectively the talents of the university and of industry. There is a constantly increasing amount of research being carried on by American industry in cooperation with educational institutions, research foundations and government bureaus. The results secured by industry through research, in cooperation with selected engineering colleges, indicate that such educational institutions can undertake and carry out successfully research projects of considerable magnitude and of benefit to industry as well as to engineering education. From the earliest days of our national existence the United States Government has conducted investigations, of a greater or lesser scientific character, in order to establish a sound basis for its legislative and administrative activities. Investigations in agriculture predominate among the fields of governmental research. Next to agriculture comes research for improved public defense. Outside of the field of agriculture practically no support has been given by government to research in higher educational institutions.

The Supplement to the *Journal of Engineering Education,* published in February, 1931, reports the status of research in engineering colleges during the year 1928–1929. During that year $2,156,863 were expended by the engineering colleges of the United States of America, and provided for the employment of 575 full-time and 807 part-time research workers.

The engineering colleges in the "land-grant" group, which represents about one third of the engineering colleges of this country and nearly one half of the engineering student enrolment of this country, had available during the year 1939–40 a total of $1,802,263 for engineering research, which was being carried on by 251 full-time and 450 part-time workers, in addition to 383 teachers who were devoting time to research without extra compensation. $962,267 of the funds expended for engineering research at the land-grant institutions during 1939–40 came from industry.

Inventions and Patent Policies

Reasons for Patent Policies. Research at educational institutions may lead to improved processes, machines, chemical compounds or articles of manufacture of potential industrial and commercial value. Thus, educational institutions found it necessary to consider patent policies in order to encourage inventive talent on the part of their staffs and students, to protect industries cooperating with them, but particularly as a protection to the institutions themselves which ordinarily do not have the facilities to administer patents and usually consider legislation and business details in handling patents entirely outside of the jurisdiction of their governing boards. In state-supported institutions the administration of patents and special payments to inventors often involve legal restrictions. Some state universities take the stand that a state institution supported by public funds has an obligation to reserve for use of the public all benefits accruing from investigations made by its staff members or others under its control. Such institutions reserve the right to all discoveries and inventions which are the direct result of the staff members' regular duties or at the expense of the university. Inventions developed outside of their regular duties or at their own expense are not the property of the university.

Research Foundations. There is a definite trend for universities to turn over their patent problems to the Research Corporation of New York, or to set up research foundations of their own, which finance research and to which the inventor assigns all rights of his research findings. Such institutional research foundations are non-profit corporations organized for the purpose of encouraging creative talent by relieving the inventor of the financial burden and loss of time from his research interests and by financing research from profits accruing from the sale or royalty on patents. The charter of such foundations usually includes a clause which authorizes them to accept "all rights and titles to inventions, and in order to protect, defend, dispose and/or arrange for the discovery or invention by members of the staff or students of the institution" affiliated with the foundation. Research foundations are granted by their charters the freedom to accept gifts. Research foundations are in a position to aid educational institutions in sharing patent rights with industry, a common practice in many industries which even license their direct competitors.

The Research Corporation of New York is the outgrowth of Dr. Cottrell's interest in the development of science and its applications. For a number of years the Research Corporation of New York concerned itself mainly with the development and installation of Cottrell Precipitators. However, the field of endeavor of this foundation has been broadened into many scientific fields, and it has taken over the handling of patent problems in educational institutions. The net earnings of this foundation are used to encourage scientific investigation.

The research foundations at universities have usually been developed as the result of an invention by a member of the institutional staff and by reason of the growth of research in cooperation with industry at educational institutions. Thus, the Cornell Research Foundation, Inc., was started after a member of the agricultural staff discovered a patentable process. At Purdue University inventions of commercial value, developed in its agricultural and engineering experi-

ment stations, led to the creation of the Purdue Research Foundation. At Wisconsin several of its alumni became interested in Dr. Harry Steinbock's discoveries relating to the use of ultra-violet rays to enrich the Vitamin D content of foods for medicinal products, and the Wisconsin Alumni Research Foundation resulted with its major objectives, "to promote, encourage and aid scientific investigations and research . . . and to assist in providing the means and machinery by which scientific discoveries of the staff may be developed and patented, and the public and commercial uses thereof determined."

Former Reports on Patent Policies of Educational Institutions. A report by a Committee of the Association of Land-Grant Colleges and Universities on Uniform Patent Practices was made on November 22, 1922, and published in the *Proceedings* of the thirty-sixth annual convention of this association (pages 283–284). This report includes the following suggestions with reference to patent policies of state institutions:

(*a*) That an institution has a right to inventions or discoveries made by the members of its staff incident to their regular duties or at the expense of the institution.

(*b*) There may be cases where the inventive genius of the investigator, while helped, no doubt, by his surroundings in the experimental laboratory, nevertheless would have evolved the same idea under circumstances where there would be no question as to it being his property. There would be other cases where, without question, the investigator could not have any moral claim personally to the ownership of the patent. Therefore, it would be rather difficult to make any hard-and-fast rule but what would work some injustice one way or the other. In any case the inventor should have some equity in the patent, but so should also the institution.

(*c*) That the main reason for securing patents on inventions is to prevent an outsider from pirating them at the expense of the public.

(*d*) The possession of a patent implies an obligation to utilize the invention for the benefit of the public. If there is danger that the patent will be filed away "under a bushel" it will be better for the institution to forego its right to inventions.

(*e*) Several were of the opinion that the inventions or discoveries made by members of engineering experiment station staffs should be made available to the public without restriction. Alfred D. Flinn, later secretary of the Engineering Foundation, brings out the fact that: "A patent *given to the public* is often most effectively withheld from the public, because no one would assume the business risk and the development expense necessary to commercialize an article over which he can have no control for a reasonable period." Only patents which have no commercial value may be properly dedicated to the public.

(*f*) The question of disposition of the patents is a most difficult problem to solve. If manufacturing rights would be granted to all who apply, responsible business concerns would not be interested. Educational and research institutions are not in a position to do commercial business, such as would be involved in owning patents, to defend the patent owned or even to negotiate successfully for the disposal of rights under patents. Unbusinesslike methods in handling patents by educational institutions would hinder rather than promote discoveries or inventions. It will be necessary to have some outside organization handle the details with reference to the disposition of the patents. The Research Corporation of New York was organized to handle patents of those who are not in a position to exploit them. In time the various engineering experiment stations may accumulate a sufficient number of patents to justify the organization of a central clearing house for the administration of such patents.

The *Journal* of the Patent Office Society for February, 1934, issued a publication by Archie MacInnes Palmer under the title "University Patent Policies." The following summary of this publication is of interest:

> Most of the research conducted at educational institutions, being primarily concerned with the extension of knowledge, is not utilitarian in view. Nevertheless, the efforts of research workers, especially in the applied sciences, frequently result in discoveries of probable, if not immediate, application.

In order that the public may derive the most good from such discoveries the educational institutions should in most cases patent the applicable results of research and direct their commercialization in an unexploitative manner. In very few cases does it seem wise to dedicate a discovery to the public.

Among the legal, administrative and ethical problems are those involved with the obligations to the public, the inventor, the industrial donor in cooperative research and the educational institution. The procedures and policies followed by universities in this country in handling these problems vary considerably.

The following patent policies reported in the Palmer bulletin are of interest:

At St. Louis University a faculty-composed Committee on Grants for Research handles patent problems and is authorized to make agreements with licensees, control the standardization of the product being made under the license and distribute the income from the patents.

At the California Institute of Technology it is the practice for any staff member, who in connection

with his research makes a patentable discovery, to assign the patent to the institute. Such action, however, is taken only when the officers of the institute think it expedient in the interest of C. I. T. The disposition of any proceeds is left to the Board of Trustees.

At the University of Toronto the governors of the university have been empowered with all the necessary authority needed for securing and administering patents. The staff member is not forced to assign his rights to the university; the facilities are merely offered staff members for their own volitional use.

At the University of Cincinnati an Institute of Scientific Research was organized in 1920 "to provide a separate unit for research in any distinctive field or for combined research in various fields." Under its management at least three separate research foundations and accompanying research laboratories under university supervision have been set up in specialized fields.

The University of Utah has made plans in 1934 for the organization of a research corporation, since the university is prohibited by law from exploiting the fruits of its research.

Present Patent Policies of Educational Institutions. The principal aspects in regard to present patent policies and practices of educational institutions were secured from 39 universities, colleges and technological institutes which included twenty-five state institutions and fourteen privately endowed universities and technological institutes. This list was made up of the state universities of California, Florida, Georgia School of Technology, Illinois, Iowa, Iowa State College, Kansas, Kansas State College, Kentucky, Maine, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, North Carolina State College, Ohio, Oregon State College, Pennsylvania State College, Purdue, Texas A. and M. College, Virginia Polytechnic Institute, Washington State College, West Virginia and Wisconsin. The privately endowed institutions included Carnegie, Case, Columbia, Cornell, Harvard, Lehigh, Massachusetts Institute of Technology, New York University, Pittsburgh, Princeton, Rensselaer Polytechnic Institute, Stanford, Stevens and Yale.

These aspects may be summarized as follows:

Twelve of the above institutions have no patent policies. These include the Case School of Applied Science, North Carolina State College, Rensselaer Polytechnic Institute, Stevens Institute and the universities of Iowa, Kansas, Kentucky, Missouri, Nebraska, New Hampshire, Pittsburgh and West Virginia.

Research foundations have been organized at seven institutions, which include Cornell, Minnesota, Ohio State University, Purdue, Virginia Polytechnic Institute, Washington State College and Wisconsin. The University of Maine is in the process of adopting a policy which will include a research foundation.

The University of California, the Massachusetts Institute of Technology and Princeton University have arrangements so that all business matters of any invention are handled by the Research Corporation of New York upon the recommendation of an institutional patent committee. New York University has no policy at present but is exploring a modified type of contract with the Research Corporation of New York.

The Carnegie Institute of Technology at Pittsburgh is now formulating a policy for the entire institute; but in its two research divisions, concerned with coal and metal investigations, the research staffs are at present under written agreement to assign all patents to the institute. This requirement does not apply to professors outside of the coal and metal research laboratories. In the case of the Coal Research Laboratory patents are held in the name of the Carnegie Institute of Technology and are administered by the Institute Board of Trustees. Patents are licensed to each of the contributing companies without cost until such remission of normal license fee shall amount to twice the total contributions made or ten times the annual contribution in the year in which the patent is granted, whichever is the greater.

Columbia University in the City of New York has a corporation controlled by a board of trustees which offers its facilities to members of the faculty in securing and administering patents, provided, in the judgment of the board, a patent is desirable in the public interest.

The University of Florida has at present under consideration a patent policy under which patents will be administered by a research council of staff members and applicable to investigations financed by the university or by an agency cooperating with it.

Harvard University is interested only in patents of its staff members which have therapeutic value. Patents of professors outside of the medical faculty of Harvard University are considered to be the private affair of the inventor.

Iowa State College handles the legal and administrative details through a joint patent committee of the college and the Iowa State Board of Education. A similar policy is found at the Georgia School of Technology where patents of staff members and students are assigned to the Industrial Development Council, a corporation of the State of Georgia which administers patents in its trust.

The University of Illinois controls all patents and under its rules requires the assignment to itself of all discoveries made by members of its staff in the course of their researches as such members, whether the research be financed from private sources or

otherwise; all patents thus acquired are controlled by the university. The application for patent is made by the staff member, and the patent is assigned to the university, which grants licenses exclusively or non-exclusively, according to the circumstances, and gives preferential consideration to private sources financing a given research. The university deals liberally with the inventor and pays him a substantial portion of the earnings from patents, after all expenses have been paid. Lehigh University has its staff members assign to the university patents resulting from cooperative research, and the royalties are equitably divided.

The patent policy of the University of Michigan involves the assignment to the regents of the university only those patent applications with inventions resulting from research projects financed by the university or by some party under contract with the university. The cooperating agency is given a non-exclusive free license to any patentable inventions which it finances. The client, however, may also elect to take full assignment and be responsible for the preparation and prosecution of the application. The university has no incorporated research foundation, but handles directly all legal and business details regarding patents.

The Pennsylvania State College requires all staff members engaged specifically to do research to assign to the college all patents resulting from their assigned duties. Other staff members are not so bound by contract, but are advised to assign patents to the college only on the occasion that the Council on Research judges that the college obviously has an equity in the work from which patents resulted. The college pays the cost of obtaining such patents and the board of trustees may transfer all rights to the Pennsylvania Research Corporation (or similar organization) for administering the patents.

At Stanford University a patent committee of the institutional faculty and administration receives reports of discoveries by staff members and students. Inventions found valuable are assigned to the university upon the recommendation of the patent committee to the president. When researches are of a cooperative nature, patent interests and rights are shared equitably with the donor in proportion to the relative contributions.

At Yale University patent matters are referred by the president to the prudential committee of the corporation which is authorized to deal with each case according to its merits.

At the State Colleges of Kansas, Oregon and Texas institutional policies with reference to patents are under consideration.

It is a policy of educational institutions not to acquire inventions other than those developed by its staff members and students.

Arrangements regarding royalties differ. Most institutions have no definite commitments. In some universities a percentage of the gross or of net earnings, 7 to 10 per cent. of the gross earnings and 15 to 50 per cent. of the net earnings, is paid to the inventor. Each case is treated separately and with particular care that equitable rewards are accorded to the inventor. At the same time recognition seems to be given to the fact that "our patent laws were enacted to encourage the development of the industries for the benefit of the public and not to reward the inventor.[2]

Those institutions which issue licenses on their patents usually determine the royalty basis in accordance with the estimated commercial possibilities of the invention, the prevailing rate in industry, whether or not the licensees financed the research project from which the patent resulted and value of the invention in connection with national defense and general public interest. Few institutions seem to feel that industry has the sole claim on patents resulting from research which it finances. The usual practice is to grant non-exclusive licenses only under conditions and restrictions calculated to produce maximum benefit to the public with due fairness to the industry which financed the research program. In some cases a moderate royalty is expected for use in development and production, as well as a certain amount of control.

Few universities and colleges have any positive policy or interest in participating in cross-licensing or patent pools; only two reported having any connection with a patent pool. Thus, at the Georgia School of Technology one case of cross-licensing, provided for the exclusive handling of licenses by the Industrial Development Council, a state corporation handling the patent problems of this institution. The University of Minnesota has entered into a partnership which might be designated as a patent pool to cover a certain specific place already occupied by a company of national and international importance in the field.

There seem to be two different policies regarding patent litigation and the defense of patent rights. Where patents are handled through the Research Corporation or through a research foundation affiliated with the educational institution, the general policy is to avoid aggressive action but to defend all clear rights even to the extent of court litigation. Some foundations insist in license agreements that the licensee as-

[2] Special Publication of the American Association for the Advancement of Science. Supplement to SCIENCE, 79, No. 1, January, 1934.

sume the expense (in part, if not all) of patent litigation. When patents are administered by the governing boards of universities and colleges, legal and political implications usually govern the actual procedure.

Sixteen educational institutions, which have cooperated in this study, report 380 patents, of which 114 are in active use. Only one university dedicated an invention to public use mainly because of its simplicity. Only five educational institutions report income from patents.

Patent policies of educational institutions apply to inventions in the public interest, inventions resulting from researches in cooperation with industry and inventions resulting from research at the expense of the educational institution. No other country in the world offers to creative genius the incentive and opportunity which are afforded by the patent system of the United States of America, provision for which was made 150 years ago in the Constitution of this country. Our patent system vitalizes and perpetuates the stimulus to invention without which technical progress would have been stifled by secrecy and selfish motives. Without question the American patent system is a major contributing factor to the industrial supremacy of America. American industry is dependent for its future progress upon our patent system, which has provided a stimulus to inventors and a protection to capital which has backed creative effort. Educational institutions can not expect to secure from industry large sums for research unless the discoveries from such investigations are protected by patents. Industries expect protection from exploitation by their competitors.

There is a general consensus of opinion that commercially valuable discoveries should not be dedicated to the public but should be patented. As Dr. Elihu Thomson has said,[3] "publish an invention freely, and it will almost surely die from lack of interest in its development—patent it, and if valuable, it will be taken up and developed into a business."

Among those institutions which have no definite patent policy there is found in some cases an attitude that an educational institution has no right to become involved in patent business, but that an invention belongs only to the inventor. In many cases authorities feel no need for a special patent policy, either because the researches in such institutions have not yielded results of particular commercial value or by reason of their interest in theoretical or basic research. In a special publication of the American Association for the Advancement of Science, Supplement to SCIENCE, Volume 79, No. 1, January, 1934, the objections to patenting, not only by institutions, but also by scientists and professors, were based on ethical and moral grounds as well as interference with research. Those objecting to an interest in patents on the part of scientists claim that patenting requires secrecy on the part of the research worker and leads to the debasement of research and to ill-feeling and jealousy on the part of the colleagues. On the other hand, the social and economic advantages that accrue from patenting the results of research that have potential commercial and industrial value far overshadow the objections mentioned.

Conclusions. Educational institutions of higher learning have produced in their research laboratories discoveries and inventions of value and importance to industry and agriculture. Not until comparatively recent years, however, have colleges and universities realized that their technical research programs would better serve mankind if commercial and public needs were strongly considered in their planning and if the cooperation of industry were available. In making the products of the laboratory available to society, colleges and universities have found that dedicating the findings of research to the public actually withholds these findings from use. Likewise, industry is very reluctant to invest in cooperative research unless patent rights are obtained for the results of research allowing adequate protection for the commercialization of the new findings. For these reasons it has been found that educational institutions operating their research programs under definite patent policies are in the best position to enhance technical progress.

Formal arrangements with staff members regarding patents usually apply to cases of research programs financed entirely by the university, college or institute or by some outside agency or donor in connection with cooperative research programs. Inventions not financed by educational institutions or by agencies cooperating with them are the property of the individual teacher or research specialist. Where research foundations have been established they are available for use by staff members in connection with their own inventions. Equitable sharing of ownership is decided upon in instances where others have a legal right to a share in the new finding. In cooperative research, even if it is financed entirely by industry, the resulting patents are assigned to the educational institution which, in turn, usually shows special consideration to the donor in the matter of licensing. The securing and administering of patent rights is considered by the governing boards of many institutions to be outside of their jurisdiction, and in state-supported colleges and universities much caution must be taken in the handling of patent matters to avoid legal difficulties. In meeting this situation, seven of the thirty-nine educational institutions, contacted in the study, have organized research foundations for administering desirable patent policies, while one other is planning such action; three have entrusted the handling of patent matters to the Research Corporation of New York,

[3] *Electrical World*, 75: 1505, 1920.

and a fourth is considering the adoption of this procedure; in two other instances a state board is given the responsibility for patent administration; patent policies and problems in thirteen other educational institutions are under the jurisdiction of faculty committees and/or governing boards. Twelve schools have not as yet organized or have not felt the need of formulating a definite patent policy. Thus about two thirds of the institutions investigated have a definite patent policy, and these include the institutions which receive the greatest support for research from industry. There is apparently no difference in the actual practice of state-supported and privately endowed institutions. Nearly as many have patent matters administered through research foundations, or the Research Corporation of New York, as through institutional governing boards.

Those universities and colleges which have definite patent policies are of the opinion that both the social and economic welfare of the public are being enhanced by their methods of handling patents and of encouraging creative activity of their staff members. Unexploitative commercialization of patents is of definite value to the public. Earnings from patents are used to reward the inventor and to support research.

The procedure of utilizing the personnel and equipment of educational institutions in cooperative research with industry is sometimes looked upon with doubt and disapproval. Colleges and universities often are prejudiced against cooperative research because of the legal and administrative problems involved, precedent and policy of governing boards and moral and ethical principles. On the other hand, industry is often skeptical of cooperative research on the grounds that educational institutions are too unbusinesslike and too theoretical in their research activities. The initiative in bridging the gap between the two groups can be taken by colleges and universities in formulating and administering patent policies designed to remove the difficulties and misunderstandings retarding cooperation between industry and educational institutions.

The fact that the income accruing to educational institutions from patents is insignificant indicates that the incentive for discovery and invention in colleges and universities is not financial reward but is involved in the fair and equitable recognition of creative genius and of aid given by industry to research. Scientific research is the main concern of higher education with reward to the institution and inventor as a secondary consideration. Inventive ability is placed on the same level as good teaching and good relationship with the public, and the creation of new scientific knowledge is recognized and rewarded. Industries cooperating with educational institutions find that a considerable number of colleges and universities through a sound patent policy are in a position to protect the findings of the research laboratory, while encouraging creative talent and reward for accomplishment.

PHYSIOLOGICAL ALTERATIONS AS THE CAUSE OF SENILE DEBILITY AND SENILE MORTALITY[1]

By Dr. HENRY S. SIMMS

COLLEGE OF PHYSICIANS AND SURGEONS, COLUMBIA UNIVERSITY

SENESCENCE is characterized by two outstanding manifestations increasing debility and increasing death rate. Of the two, debility seems to cause the greater concern to the average individual. The data discussed in this paper indicate that both these manifestations of senescence may result from the same physiological alterations.

When the logarithm of the probability of death (log P_t) is plotted against the age of the individual (t) a straight line curve after the age of 35 is obtained. This may be expressed by the equation:

$$P_t = P_o e^{kt} \quad (1)$$

where k is a positive constant and P_o is the (extrapolated) probability of death at the time of birth. This is another way of expressing the law of Gompertz,[2] which was published in 1825. For total deaths in 1936 from all causes k is equal to 0.078, which means that the probability of death increases 8.1 per cent. each year in a manner analogous to the accumulation of compound interest.

Most of the diseases[3] (namely, groups A and B in

[1] This investigation has been aided by grants from the Josiah Macy, Jr. Foundation and the John and Mary Markle Foundation.

[2] B. Gompertz, *Phil. Trans. Roy. Soc. London*, 1825. For a discussion of attempts to interpret the biological significance of this and other equations, see Bernstein, *Symp. Quart. Biol.*, 2: 209, 1934. See also A. Putter, *Naturwissenschaften*, 8: 201, 1920, and K. Kupfmuller, *ibid.*, 9: 25, 1921. An equation for "loss of vitality" was used by S. Brody (*Jour. Gen. Physiol.*, 6: 245, 1923). "Vitality" was the reciprocal of "Mortality," so that k was negative. This was applied to egg-laying and to healing of wounds.

[3] E. B. Nathan (*Trans. of the Faculty of Actuaries*, 10: 45, 1924) stated that diseases can be classified according to whether or not they follow Gompertz's law or Makeham's modification of that law. Our data, from a different country and decade, are in general agreement with Nathan's in that the following diseases do not obey equation (1): accidents, tuberculosis, infancy, childbirth, congenital malformations and chronic alcoholism. The reasons are obvious, except for tuberculosis and alcoholism.

TABLE 1*

GROUP A. DISEASES WHICH OBEY EQUATION (1) WITH A LOW VALUE OF k

Cause of death	k
Infectious diseases (except T.B.)	0.044
Digestive diseases	0.048
Lobar pneumonia	0.046
Diseases of the nervous system (not including cerebral hemorrhage, embolism or hemiplegia)	0.046
Respiratory diseases (except T.B. and pneumonia)	0.053
Goiter, pellagra, arthritis, etc.	0.053
Diseases of skin and bones	0.046
Average	**0.048**

GROUP B. DISEASES WHICH OBEY EQUATION (1) WITH A HIGH VALUE OF k. THE VALUES IN PARENTHESES ARE LESS CONSTANT THAN THE OTHERS

Cause of death	k
Cerebral hemorrhage	0.104
Chronic nephritis	0.101
Cerebral embolism and thrombosis	0.106
Hemiplegia and unspecified paralysis	0.108
Chronic myocarditis and myocardial degeneration	0.120
Arteriosclerosis	0.145
Miscellaneous and unspecified heart disease	0.095
Chronic endocarditis	(0.085)
Coronary arteries	(0.106)
Angina pectoris	(0.106)
Average	**0.108**

GROUP C. CAUSES OF DEATH WHICH INCREASE WITH AGE BUT HAVE CHANGING VALUES OF k

	Cause of death	k in middle age	k in old age
Decreasing k	Cancer	0.13	0
	Diabetes mellitus	0.14	−0.04
Increasing k	Bronchopneumonia	0.06	0.11
	Trauma from falling (not mechanical)	0.06	0.13
	Genito-urinary diseases except chronic nephritis and prostate	0.04	0.08

* These values of k were calculated from the mortality data in the United States in 1936 (Bureau of Census, Special Reports, Vol. 5, No. 41, page 303). The causes of death are those of the International List.

Table 1) have death rates which increase with age according to this equation after the age of 30. These may be divided into two groups: Diseases in group A have a value of k equal to about 0.048. The death probability from any of these diseases increases about 5 per cent. each year. The other group (B) consists of diseases having a much higher value of k, namely 0.105, which means that the death probability from each disease in this group increases about 11 per cent. each year. Although this classification was made entirely on the basis of the k values (slopes of the curves), it will be seen that group B is composed essentially of vascular diseases. These cause over 50 per cent. of the deaths after the age of 30.

Groups A and B are distinct from each other with no gradation between,[4] although there are some irregular diseases (such as cancer, diabetes, bronchopneumonia, etc.) which increase with age but have a variable k. The few remaining causes of death[3] are not correlated with senescence.

In Table 1 it will be noted that although the diseases in group A are widely diversified, nevertheless, their lethalities increase at nearly identical rates (k values). This suggests that the lethality of each of these diseases is dependent upon a common physiological state or function which changes with age. This function, designated by the letter Q, may be defined by the equation:

$$Q_t = Q_0 e^{k_Q t} \tag{2}$$

where Q_t is the value of Q at age t, and k_Q (the constant for the group A diseases) is equal to 0.048, corresponding to a 5 per cent. increase in the value of Q each year.

The change in Q may be a single physiological alteration, or it may be the resultant of several alterations. There are indications (from "case mortality" data) that the change in Q affects mortality by increasing the death rate when disease is present, rather than by increasing the tendency to become diseased. This is an important point which needs thorough investigation. A study of the physiology of death should help to clarify the problem.

If we assume[5] that the change in the Q function affects deaths from diseases in group B as well as group A, then the faster increase in death probability of the vascular diseases may be ascribed to the alteration of a second physiological function (or composite function) R, according to the equations:

$$Q_t R_t = Q_0 R_0 e^{(k_Q + k_R)t} = Q_0 R_0 e^{0.108t} \tag{3}$$

$$R_t = R_0 e^{k_R t} = R_0 e^{0.06t} \tag{4}$$

The nature of this R function is also unknown, although it may very well be some property of the vascular system such as the arterial distensibility or capillary permeability. It has been suggested that the faster change of the vascular diseases may be due merely to a greater action of the Q function. This would merely alter Q_0 but not k. However, it is possible that R is a property which gives the Q function a greater opportunity to exert its lethal action.

Objection might be raised to the use of the U. S. Mortality Statistics on the ground that many of the diagnoses of the cause of death may be wrong; first, because of the presence of several pathological conditions in a single individual; second, because the

[4] Except for diseases of the blood-forming organs ($k = 0.062$).

[5] This assumption is partly warranted by the fact that if the increasing death rate in group B were due to the alteration of a single function this alteration would reach such enormous values that it would probably have been already discovered. It would increase 650 fold between the ages of 30 and 90, whereas the Q and R functions increase 18 and 32 fold, respectively, during this period. Although the vascular deaths might be controlled by two or more alterations not including the Q function, this seems improbable for two reasons: First, if the Q function controls deaths from such a variety of unrelated causes as are found in group A, it would be strange if the vascular diseases were unaffected by it. Second, a progressive change which obeys an exponential equation such as equation (2) is rather unusual and, although the evidence indicates there are at least two such changes, the probability of three or more simultaneous exponential changes is small.

terminal disease may not indicate the underlying disease; and third, the underlying disease may in itself result from some pathological condition. Thus an individual with arteriosclerosis might develop nephritis and die with terminal pneumonia. We have taken this into account and feel that these inaccuracies do not alter our general conclusions. Whatever the mistakes in diagnosis may be (within group A or group B) the values of k will not be affected provided the same mistakes are made at all ages. The consistency within each group indicates that this is the case and that cross-diagnosis between the groups does not play a large role (except after the age of 80).

Senile debility is not as easily measured as the death rate is. However, a composite measure of both physical and mental debility is given by the data on male unemployment. We admit that this is only a crude measure of debility, but feel that most of the complicating influences affect the value of P_o rather than the value or constancy of k. It was found that in 1930 the probability of male unemployment followed equation (1) after the age of 50, with k equal to 0.115 (and approximated this equation from 40 years up). The data in 1920 are consistent with the 1930 findings. These values are for unemployment from all causes. Data on "Unemployment Class C" (admittedly unable to work) in six northeastern states also follow equation (1) but with a lower value of k (0.032). The unwillingness of older people to admit disability may make this value less reliable. Nevertheless, the agreement with equation (1) is significant.

Thus there is a statistical correlation between senile debility and senile death rate. This suggests that the progressive debility in old age is caused by an alteration of the same (Q and R) functions which control the death rate.

This brief report is preliminary to a more detailed treatment of the data which will be submitted to another journal. The author hopes that these findings may help define the problem of senescence, and that the equations may serve as a tool in determining whether or not observed changes with age are primarily correlated with senescence. This is determined as follows: The logarithms of the observed values are plotted against numerical age. If the change is correlated with senescence, a straight line curve will be found in middle life and old age. The slope of the line gives the value of k which can be compared with $k_Q = 0.048$ and $k_R = 0.06$ (on a natural logarithm basis). Experimental prolongation of life of animals may be considered to affect senescence only if there is a decrease in the value of k for known causes of death of mature adults, rather than a reduction in deaths through a lowering of the value of P_o for certain diseases. The author feels that superficial characteristics, such as the condition of the hair and skin, are unsatisfactory criteria of senility. More knowledge concerning the physiology of death and the physiology of arteries is needed in order to clarify the mechanism of senescence.

These findings also show that for the most part no disease can be called a "senile disease" more than another in the same group. The high death rate in old age is the result of changes which make us succumb more readily to all diseases, although the change is faster for the vascular diseases. Nearly four deaths out of five after the age of 30 are due, not to a greater prevalence of disease, but rather to the change in the Q and R functions which increases the death rate from the same diseases which affect young people.

The theory that senescence results from a random accumulation of degenerative changes is not supported by these findings. A random accumulation should follow a linear equation rather than the exponential equations (2) to (4). It is perhaps correct to say that there is an accumulation of degenerative changes, but that the process follows a definite mechanism such that the rate of change at any age depends upon the amount of accumulated change. Why this mechanism should be followed remains to be determined.

As was mentioned above, there seems to be more popular concern about senile debility than about senile death rate. Should we be correct in our assumption that these are both caused by the same physiological alterations, then it is to be expected that any mitigation of these alterations will prolong the vigor of youth as well as delay death in old age. This would mean a prolonged middle life with a relatively smaller portion of life spent in dependency.

OBITUARY

LETA S. HOLLINGWORTH

DR. LETA S. HOLLINGWORTH, member of the staff of Teachers College, Columbia University, since 1916 and a world-renowned authority on the psychology and education of exceptional children, died on November 27, in the Columbia-Presbyterian Medical Center in New York City. She was the wife of Dr. H. L. Hollingworth, professor of psychology in Barnard College, Columbia University.

Professor Leta S. Hollingworth was born in Chadron, Nebraska, the daughter of John G. and Margaret D. Stetter. She received her B.A. degree from the University of Nebraska in 1906, in the same class with her husband. Together they were honored for distinguished contributions to science and education by their alma mater, which conferred on them the degree of doctor of laws in June, 1938.

After her graduation Mrs. Hollingworth taught

English in Nebraska high schools for two years. Coming to New York City in 1908, she was married to Mr. Hollingworth, and shortly began her graduate study in psychology and education. She received the M.A. degree from Columbia and was appointed clinical psychologist at the Post-Graduate Hospital in 1913. A year later she joined the staff at Bellevue Hospital. Having continued her graduate study during these years, she received the Ph.D. degree from Columbia in 1916 and was immediately appointed instructor in educational psychology at Teachers College. She served continuously as a member of the staff of Teachers College until her death, advancing to the rank of assistant professor in 1919, associate professor in 1922 and full professor in 1929.

Professor Hollingworth's first field of specialization was the area of mental and emotional abnormality. In her approach to this field, she combined research and professional experience. In addition to her dissertation, a study of the mental and emotional effects of functional periodicity in women, she published many reports of laboratory investigations and clinical studies. For nearly twenty years she conducted classes at Teachers College in clinical psychology. She was co-author of an important treatise, "The Problem of Mental Disorder," published in 1934. During a period characterized by diversities and frequently extravagance of theory, Professor Hollingworth's practice and writings were distinguished by their soundness, astuteness and complete freedom from contagion by the parade of "isms."

Upon taking her post at Teachers College, Professor Hollingworth entered with her characteristic zeal and insight into three other related fields: the psychology of special talents and defects; the psychology and education of intellectually subnormal children and the psychology and education of gifted children. In each of these areas she quickly achieved a position of leadership which steadily grew more pronounced and was at the zenith at the time of her death—at 53 years of age.

In her investigations of special abilities and disabilities, Professor Hollingworth explored spelling, reading, drawing, painting, music and other activities. One of the earliest studies was reported in a monograph, "Psychology of Special Disability in Spelling," 1918, and in her volume "Special Talents and Defects," first published in 1923, she presented a comprehensive survey of the whole field.

Professor Hollingworth's investigations established her early as the leading authority in the psychology and education of subnormal and delinquent children. Her "Psychology of Subnormal Children" has been a standard text since its publication in 1920. She was responsible for the establishment of special classes for subnormal children in many communities and served as adviser to the officers in charge of this type of education in New York and many cities, states and foreign nations.

The field in which Professor Hollingworth worked with the greatest enthusiasm and vigor is the psychology and education of the gifted child. Early in her career she arranged with Dr. Jacob Theobald and other officers of the New York City schools for the selection and segregated education of a group of intellectually gifted children. She worked zealously with these pupils from the time they formed a public-school class of pupils less than ten years old until her death twenty years later. A stream of articles, monographs, dissertations and books poured from her work, combined with that of graduate students attracted by her during these years. As in other areas, her book "Gifted Children," published in 1926, became the standard text for schools of education. In her "Psychology of the Adolescent" (1928), she wrote what is doubtless the most penetrating analysis ever offered of the characteristics, problems and educational needs of all types of individuals, normal and unstable, bright and dull, talented and defective, during the teens.

Recognizing the importance of her work with exceptional children, the Board of Education of New York City and the administrative staff of Teachers College established in February, 1937, with Professor Hollingworth as executive officer in charge of research, an experimental school, known as P.S. 500, the Speyer School, for five years of further investigation. In this school, new curricula were put into effect, and an extensive array of researches was inaugurated under her direction. To these projects she devoted herself with intense enthusiasm. Although many reports have been published, it is stark tragedy that death came to her at a time when the most important investigations were still a year from completion.

Professor Hollingworth's work with exceptional children gave expression to the fundamental traits of her character and personality. Her decisions and opinions were based on cold facts; she was a staunch and courageous opponent of all forms of educational wishful thinking. Although her judgment was always impervious to the appeal of sheer sentimentality, which she despised, she was capable of the deepest affection for human beings and intense devotion to human welfare. The subjects of her studies were never human guinea pigs to her; they were the individual objects of her deepest concern. A fact, not widely known, is that she remained continually on intimate terms with all the members of her various experimental groups of gifted children, visiting them, encouraging and advising them and in a great many cases supplying tangible necessities for the pursuit of education through elementary, high school and college and graduate study. She lived to see and help her earliest group arrive at adult status; keen must have been her regret

if she realized during her illness that her most recent group of more than fifty gifted children, gathered exclusively from financially poor homes and now averaging about twelve years of age, must carry on without her. This intense interest in and devotion to the living individual, undistorted by sentimentality, and coupled with the clear-eyed vision of the scientist, of whose tools she was a master, account for the unique scientific validity and practical value of Professor Hollingworth's work.

Professor Hollingworth cherished a deep faith in the power of honest scientific work to promote human welfare. Her faith was well expressed in an address given before an audience of educators and laymen a year ago under the title, "What We Know About the Early Selection and Training of Leaders," from which a paragraph is quoted.

"All this knowledge has been gleaned since 1900, and it is a goodly amount. It is enough to modify education and social-economic procedure radically, if it becomes generally disseminated and accepted. These facts would be epoch-making, if applied to the limit of their power to apply. For a long time people will not believe them, will be afraid of them, will not know what to do with them, but in the end the truth will be admitted and utilized, as everything is finally utilized that has power to bring order to human life."[1]

ARTHUR I. GATES

TEACHERS COLLEGE,
COLUMBIA UNIVERSITY

RECENT DEATHS

DR. WILLIAM SNOW MILLER, professor emeritus of anatomy at the University of Wisconsin, died on December 26. He was eighty-one years old.

DR. CHARLES DAVID MARX, professor emeritus of civil engineering at Stanford University, died on December 31. He was eighty-two years old.

DR. GEORGE EMERSON BREWER, professor emeritus of surgery at the College of Physicians and Surgeons of Columbia University and surgical director of the Presbyterian Hospital, New York City, died on December 24. He was seventy-eight years old. In recent years he had been research associate in somatic anthropology at the American Museum of Natural History.

Nature records the death of Sir William Prout, authority in tropical medicine, at the age of seventy-seven years; of P. H. Grimshaw, keeper of the department of natural history in the Royal Scottish Museum; of Professor Anton Freiherr von Eiselsberg, the Vienna surgeon, at the age of seventy-nine years; of Dr. Richard I. Meyer, professor of inorganic chemistry at Berlin, at the age of seventy-four years; of Dr. F. Y. Loewinson-Lessing, director of the Petrographical Institute of Moscow, at the age of seventy-eight years, and of Sir Ernest Scott, emeritus professor of history in the University of Melbourne and president in 1939 of the Australian and New Zealand Association for the Advancement of Science, aged seventy-one years.

SCIENTIFIC EVENTS

OCCURRENCE OF A DEPOSIT OF TRONA

OCCURRENCE of a thick deposit of trona at a depth of about 1,600 feet on government land in Sweetwater County, Wyoming, is announced by the Geological Survey, Department of the Interior. The mineral, which is composed of sodium carbonate, sodium bicarbonate and water and which contains when pure the equivalent of 70.35 per cent. sodium carbonate, was found in the core of the John Hay, Jr., oil and gas well drilled by the Mountain Fuel Supply Company.

The drill log of the well indicated that a deposit of a crystalline sodium salt streaked with greenish gray clay extended from a depth of 1,590 feet to a depth of 1,612 feet, and that a dark oil shale containing sodium salt crystals extended from a depth of 1,612 feet to a depth of 1,620 feet.

Sections of the core obtained between the depths of 1,590 feet 3 inches and 1,619 feet 9 inches and between 1,653 feet 2 inches and 1,659 feet 3 inches were subsequently identified as trona and analyzed in the chemical laboratory of the Geological Survey with the following results:

Depth				*Equivalent sodium carbonate*
Ft.	*inches*	*to ft.*	*inches*	*per cent.*
1590	3	1591	6	69.27
1592	6	1600	4	67.38
1617	6	1619	9	69.05
1653	2	1654	8	64.45
1654	10	1659	3	68.64

The analytical results indicate the presence of relatively pure trona, which is soluble in water. The insoluble material associated with the trona included clay, 3.9 per cent.; shortite, 1.4 per cent., and one fourth of 1 per cent. of pyrite.

The core obtained between the depths of 1,185 feet and 1,820 feet is estimated by the survey to contain about 15 per cent. of the mineral shortite, a double salt of sodium carbonate and calcium carbonate, which mineral was discovered in this well. Pure shortite contains 34.6 per cent. of sodium carbonate.

Two other rare minerals, northupite and pirssonite, have been identified in the core in small quantities. This is the second known occurrence of northupite, a

[1] *The Teachers College Record*, 40: 579, April, 1939.

triple salt of sodium carbonate, magnesium carbonate and sodium chloride, and the third known occurrence of pirssonite, which is a double salt of sodium carbonate, calcium carbonate and water.

The samples were supplied by the company to H. I. Smith; the trona was identified by R. C. Wells, and the shortite, northupite and pirssonite by J. J. Fahey, all of whom are members of the U. S. Geological Survey.

W. C. MENDENHALL,
Director

THE FINANCES OF THE AMERICAN CHEMICAL SOCIETY

AT the recent meeting of the Board of Directors of the American Chemical Society, according to *Industrial and Engineering Chemistry*, the secretary of the society, Dr. Charles L. Parsons, gave a detailed report covering membership, subscriptions and the income of the society up to November 30, 1939, showing a definite increase in subscriptions to all journals, an increase in membership from 22,187 to 23,505; the election of 2,537 new members in 1939; an increase in student members and corporation members and in student affiliates. He also reported increased subscriptions to the industrial and analytical editions of *Industrial and Engineering Chemistry* and an especially large increase in the *News Edition* from 25,770 to 27,837.

The estimated income and expenditures of the society for 1940 are given as follows:

ESTIMATED INCOME, 1940

Dues	$200,000
Subscriptions	190,000
Back Numbers	6,000
Postage	17,500
Interest	21,000
Interest from Endowment Fund	3,000
Directory	3,000
Royalties	3,000
Advertising	182,000
Total	$625,500
From Reserve	45,057
	$670,557

ESTIMATED EXPENDITURES, 1940

Journal of American Chemical Society	$ 68,300
Chemical Abstracts	195,900
Industrial and Engineering Chemistry including Analytical Edition	162,336
News Edition	52,850
News Service	9,266
Secretary and Business Manager's Office:	
Secretarial	19,472
Business Management	29,208
Treasurer's Office	9,500
President's Office	1,500
Printing Advertising	57,650
Advertising Development	13,050
Technologic Monographs	1,025
Scientific Monographs	1,000
Back Numbers	4,000
Local Sections	24,000
Incidentals	15,000
General Meetings	2,000
Directory	4,500
Total	$670,557

THE PERMANENT SCIENCE FUND OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES

INCOME from the Permanent Science Fund, according to agreement and declaration of trust, shall be applied by the American Academy of Arts and Sciences to such scientific research as shall be selected ". . . in such sciences as mathematics, physics, chemistry, astronomy, geology and geography, zoology, botany, anthropology, psychology, sociology and economics, history and philology, engineering, medicine and surgery, agriculture, manufacturing and commerce, education and any other science of any nature or description, whether or not now known or now recognized as scientific, and may be applied to or through public or private associations, societies, or institutions, whether incorporated or not, or through one or more individuals."

Applications for grants under this indenture are considered by a committee of this academy on stated dates only. The next meeting to consider applications will be held on March 1. Applications should be made on special forms furnished by the committee. Correspondence, including requests for application blanks, should be addressed to the chairman of the Committee on the Permanent Science Fund, Professor John W. M. Bunker, Massachusetts Institute of Technology, Cambridge, Mass.

Grants-in-aid from this fund were voted by the academy on October 11, 1939, as follows:

Professor Orlin Biddulph, Department of Botany, State College of Washington, for further studies with radioactive phosphorus in plants, $200.

Professor Hyman Y. Chase, Department of Zoology, Howard University, for further studies on the effect of ultra-violet upon cell division in marine eggs, $300.

William G. Clark, instructor, Department of Zoology, University of Minnesota, for assistance, animals and expendable materials in his investigation of the relations between adrenal cortex and membrane functions, $400.

Dr. Rudolf Hoeber, visiting professor of physiology, University of Pennsylvania Medical School, for compensation of an assistant in a study of the relation between molecular configuration of dye-stuffs and their secretion by the kidney, $600.

Lewis H. Kleinholz, instructor in biology, Cambridge

School of Liberal Arts, for purchase of test animals in a determination of the distribution of the pituitary hormone, intermedin, $75.

Professor Robert H. Lowie, Department of Anthropology, University of California, for an investigation by Snr. Curt Nimuendaju, of the Kayapo Indians, and their cogeners in the region west of the Araguaya River, Brazil, $500.

William G. Lynn, associate in zoology, The Johns Hopkins University, for the cost of illustrations of a monograph on amphibians of Jamaica, B. W. I., which has been accepted for publication, $170.

Professor Thomas L. Patterson, Department of Physiology, Wayne University College of Medicine, for purchase of animals for his study of the effect of changed emotional states on body activity, $60.

Professor William B. Redmond, Department of Biology, Emory University, for the purchase of animals required in a further study of a new method of immunization against malaria, $350.

Edward J. Schremp, instructor in physics, Washington University, for materials and equipment to be used in the determination of directional distribution of cosmic rays at St. Louis, $500.

Professor C. Richard Soderberg, Massachusetts Institute of Technology, for his investigation of the plastic properties of polycrystalline metals, the award to be contingent upon the securing by the applicant of sufficient funds to assure the continuation of this project for at least one year, $500.

David M. Steven, Henry fellow, Harvard University, for his investigation of night blindness as an index of vitamin A deficiency among the population of Labrador and North Newfoundland, $400.

Martin D. Whitaker, instructor of physics, New York University, for one year's rental of a radium-beryllium source of neutrons for his studies on differential effects in slow neutron scattering, $850.

THE WESTERN SOCIETY OF NATURALISTS

THE twelfth annual winter meeting of the Western Society of Naturalists was held in the San Carlos Hotel in Monterey, California, December 20, 21, 22 and during the morning of December 23. Preceding a smoker on the evening of December 20, Dr. Harald U. Sverdrup, director of the Scripps Institution of Oceanography, talked briefly of the recent work and forthcoming program of the institution's scientific operations at sea, and then showed colored motion pictures taken by Dr. Roger Revelle, of the staff, during a research cruise last spring in the Gulf of California.

Two symposia were given in honor of two respective octogenarian members. An evening dinner was given also in their honor. The first symposium was "The Biological Basis of Social Problems," honoring Dr. William E. Ritter, professor emeritus of zoology in the University of California and first director of the Scripps Institution of Oceanography; contributors to this symposium were: Dr. C. M. Child, Dr. F. B. Sumner, Dr. S. J. Holmes, *chairman,* Dr. E. B. Copeland and Dr. H. S. Jennings. Contributors to the second symposium, honoring Dr. Douglas H. Campbell, and entitled "The Evolution of Land Plants," were: Dr. A. W. Haupt, Dr. G. M. Smith, *chairman,* Dr. I. L. Wiggins and Dr. H. F. Copeland.

Besides some twenty-seven contributed papers, two other symposia were presented. They were "Nutrient Requirements of Microorganisms," under the chairmanship of Dr. C. B. van Niel, Hopkins Marine Station, Pacific Grove, and "Animal Migration," under the chairmanship of Dr. R. C. Miller, California Academy of Sciences, San Francisco.

The following officers were elected: *President,* Professor George E. MacGinitie, Kerckhoff Marine Biological Laboratory of the California Institute of Technology, Corona del Mar; *Vice-president,* Dr. Robert C. Miller, director of the California Academy of Sciences, San Francisco; *Secretary-Treasurer,* Dr. Denis L. Fox, Scripps Institution of Oceanography, La Jolla; *Members of the Executive Committee,* Dr. Gilbert M. Smith, Stanford University, and Dr. S. F. Light, University of California, Berkeley.

D. L. Fox

THE PRIZE OF THE AMERICAN ASSOCIATION

THE American Association prize of $1,000 was awarded at the Columbus meeting to Dr. I. I. Rabi, professor of physics at Columbia University. The nominating committee in announcing the award made the following statement:

As in past years the committee found it difficult to choose from almost equally meritorious contributions in scientific fields so different that comparison and contrast were impossible.

Notwithstanding this difficulty, the committee reached a unanimous decision in favor of Dr. Rabi's research as outlined in his paper, "Radio Frequency Spectra of Atoms and Molecules" because it extends the range of scientific knowledge regarding atoms in a very significant way.

Dr. Rabi has not only discovered radiations, emitted by atoms, that are pitched lower than any hitherto observed but also devised a method of measuring them. Although they lie within the range of radio, they are too feeble by far for detection by even the most sensitive devices now known in radio.

Dr. Rabi's work has opened a way of measuring such subtle properties of atoms and molecules as the magnetism of their component parts a hundred times more accurately than was possible by any instrument available up to the present time. Of special significance is his conclusion that "there are no forces between the nucleus and the electrons because of their spins, other than those arising from the fact that the nucleus, as well as the electron, is a magnet."

SCIENTIFIC NOTES AND NEWS

DR. ALBERT F. BLAKESLEE, director of the department of genetics of the Carnegie Institution of Washington, Cold Spring Harbor, Long Island, was elected at Columbus on December 30 president of the American Association for the Advancement of Science. He succeeds Dr. Walter B. Cannon, George Higginson professor of physiology at the Harvard Medical School. Dr. Blakeslee is a member of the National Academy of Sciences and of the American Philosophical Society and was chairman of the section for the botanical sciences of the association in 1918.

DEAN EDWARD ELLERY, professor of chemistry and chairman of the faculty of Union College, Schenectady, N. Y., was elected president of the Society of the Sigma Xi at the Columbus meeting. Dr. Ellery has been national secretary of the society for eighteen years. His place as secretary will be taken by Professor George A. Baitsell, of Yale University, the retiring president of the society.

THE American Philosophical Society, meeting at Columbia University, held a special three-hour morning session on December 27 in honor of Dr. John Dewey, professor emeritus of philosophy at the university, who celebrated his eightieth birthday last October. The speakers were Dr. William E. Hocking, professor of philosophy at Harvard University; Dr. Morris R. Cohen, professor emeritus of philosophy at the College of the City of New York, and Dr. Dewey.

DR. A. ADRIAN ALBERT, assistant professor of mathematics at the University of Chicago, was awarded the Cole prize for mathematics of the American Mathematical Society at the Columbus meeting. This prize is awarded every five years to "the person who solves a famous or difficult problem in mathematics."

PRESENTATION of the Theobald Smith Award in the Medical Sciences, founded by Eli Lilly and Company, "to recognize demonstrated research in the field of the medical sciences, taking into consideration independence of thought and originality," was made to Dr. Albert B. Sabin, associate professor of pediatrics at the University of Cincinnati and fellow of the Children's Hospital Research Foundation, formerly of the Rockefeller Institute for Medical Research, on December 28 at the Columbus meeting of the American Association. Dr. Walter B. Cannon, president of the association, made the presentation, after which Dr. Sabin described the work for which the award was made. His address, which will shortly appear in SCIENCE, was entitled "Constitutional Barriers to Involvement of the Nervous System by Certain Viruses."

DR. JOHN G. KIDD, research assistant of the Rockefeller Institute for Medical Research, has received the 1939 Eli Lilly Award of $1,000 and a bronze medal of the Society of American Bacteriologists for his research work on animal cancer. The award is made annually to a man or woman under thirty-one who has made outstanding contributions to knowledge in the fields of bacteriology or immunology while conducting investigative work in a college or university in the United States or Canada.

DR. FRANK N. WILSON, professor of internal medicine at the University of Michigan, has been awarded the Henry Russell lectureship. Dr. Wilson is the fifteenth member of the faculty of the university to be named to the lectureship, which was established by a bequest of the late Henry Russell, of Detroit, a member of the class of 1873. The lecturer is chosen each year by the council of the University Research Club.

DR. RAYMOND PEARL, professor of biology in the School of Hygiene and Public Health of the Johns Hopkins University, was elected at the Philadelphia meeting a member of the Board of Directors of the American Statistical Association. Dr. Pearl is the retiring president of the association.

DR. CHARLES THOM, who is in charge of soil microbiology in the Bureau of Plant Industry of the U. S. Department of Agriculture, was elected at the New Haven meeting president of the Society of American Bacteriologists to succeed Dr. Arthur T. Henrici, of the University of Minnesota. Dr. Oswald T. Avery, member of the Rockefeller Institute for Medical Research, was elected vice-president; Dr. I. L. Baldwin, professor of bacteriology and dean of the College of Agriculture of the University of Wisconsin, was elected secretary-treasurer.

THE REV. DR. JOHN M. COOPER, professor of anthropology at the Catholic University of America, was elected president of the American Anthropological Association at the thirty-eighth annual meeting in Chicago. Other officers elected were: *First Vice-president,* Dr. Elsie Clews Parsons; *Second Vice-president,* Dr. Earnest A. Hooton, of Harvard University; *Third Vice-president,* Dr. William Duncan Strong, of Columbia University; *Treasurer,* Dell Weitzner, of the American Museum of Natural History; *Editor of the American Anthropologist,* Professor Ralph Linton, of Columbia University. The next annual meeting will be held in December at Philadelphia.

DR. S. S. WILKS, assistant professor of mathematics at Princeton University, was elected president at the

Philadelphia meeting of the Institute of Mathematical Statistics. Dr. Allen T. Craig, assistant professor of mathematics at the State University of Iowa, and Dr. Cecil C. Craig, associate professor of mathematics at the University of Michigan, were elected vice-presidents. Dr. Paul R. Rider, associate professor of mathematics at Washington University, St. Louis, was elected secretary-treasurer.

OFFICERS for the coming year of the Botanical Society of Washington have been elected as follows: *President,* M. C. Merrill; *Vice-president,* Nellie W. Nance; *Recording Secretary,* Charles Drechsler; *Corresponding Secretary,* Miriam L. Bomhard; *Treasurer,* N. Rex Hunt; *Councillors,* M. T. Jenkins, S. B. Detwiler; *Representative to the Washington Academy of Sciences,* Charles Thom.

DR. CARLOS EUGENE PITKIN has been promoted to a clinical professorship of otolaryngology at the School of Medicine of Western Reserve University.

DR. HALE F. SHIRLEY, assistant professor of psychiatry, State University of Iowa College of Medicine, Iowa City, has resigned to become assistant professor of psychiatry and pediatrics at Stanford University School of Medicine and director of the Child Guidance Clinic, San Francisco.

ACCORDING to the London *Times,* the Governor of Ceylon, using his emergency powers, has appointed Dr. Collingwood Startup professor of physiology and registrar of the Medical College. Dr. Startup was selected by the Secretary of State, but the Medical Council, supported by the State Council, refused to sanction the appointment.

DR. ALEXIS CARREL, formerly a member of the Rockefeller Institute for Medical Research, has joined the staff of the French Ministry of Public Health for the duration of the war.

DR. ALEXANDER W. BLAIN, professor of clinical surgery at the College of Medicine of Wayne University, has been reelected for a fourth three-year term as a director of the Gorgas Memorial Institute of Tropical and Preventive Medicine. The institute maintains executive offices in Washington and a research laboratory in Panama.

DR. JUSTIN L. POWERS, assistant professor of pharmacy at the University of Michigan, was elected chairman of the Committee on National Formulary and director of the laboratory of the American Pharmaceutical Association at the recent semi-annual meeting held in Washington. He succeeds Dr. E. N. Gathercoal, who has been chairman of the committee since 1929 and director of the laboratory since it was established in 1935. Dr. Gathercoal will continue in an advisory capacity until after the meeting of the association in Richmond in May. Dr. Powers will give his full time to the position and will after March 1 have his headquarters in the American Institute of Pharmacy in Washington, D. C. Dr. Robert R. Hannon, superintendent of New York Hospital, New York City, has been appointed secretary of the New York State Board of Medical Examiners and executive secretary of the Medical Grievance Committee.

DR. FRITZ ROSTLER, of the Wilmington Chemical Corporation, has been appointed to the research fellowship in chemical technology established by the corporation at Newark, N. J.

THE Committee on Scientific Research of the American Medical Association has made a grant to Dr. A. S. Wiener, serologist and bacteriologist in the office of the Chief Medical Examiner of New York City, for his research on agglutinogens of human blood and the Kline test.

DR. SAMUEL L. SIEGLER, of Brooklyn, N. Y., has received a grant from the Lakeside Laboratories, Inc., of Milwaukee, to be used in a study on the metabolism of progesterone.

DR. C. E. DOBBIN, geologist in charge, and W. B. Kramer, associate geologist, at the Denver office of the mineral classification division of the Conservation Branch of the U. S. Geological Survey, have recently completed and submitted for official use detailed maps of the areal and structural geology of the East Lance Creek Oil and Gas Field, Niobrara County, Wyo., and of the Red Springs Anticline, Hot Springs County, Wyo.

DR. EDWARD D. CHURCHILL, John Homans professor of surgery at the Harvard Medical School and chief of the West Surgical Service at the Massachusetts General Hospital, will give the seventh E. Starr Judd lecture at the University of Minnesota on March 14. His subject will be "Surgery of the Lungs." The late Dr. Judd, an alumnus of the Medical School of the University of Minnesota, established this annual lectureship in surgery a few years before his death.

THE officers of the International Pediatric Congress, planned to be held in Boston in 1940, have announced that the congress has been indefinitely postponed.

THE fifty-sixth meeting of the American Association of Anatomists will be held at the University of Louisville, Kentucky, on March 20, 21 and 22.

THE eighth biennial symposium on organic chemistry of the American Chemical Society opened at St. Louis on December 28. The address of welcome was made by Dr. Edward A. Doisy, professor of chemistry at St. Louis University and director of the department. The response was made by Dr. Frank C. Whitmore, research professor of organic chemistry

and dean of the School of Chemistry and Physics of Pennsylvania State College, a past president of the American Chemical Society. Other speakers included: Dr. Carl R. Addinall, research chemist, director of library services of Merck and Company, and Dr. Lee I. Smith, chief of the division of organic chemistry of the University of Minnesota.

THE *Journal* of the American Medical Association announces the endowment of the J. B. Whitehead chair of surgery at the School of Medicine of Emory University. The establishment of the chair was made possible by the gift of $250,000 by the Joseph B. Whitehead Foundation.

A CONTRIBUTION of $10,000 from an anonymous donor to finance the continuation of research work in cancer during 1940 at St. Luke's Hospital, New York City, has been announced. The work will be carried on under the direction of Dr. Francis Carter Wood, director of laboratories.

E. I. DU PONT DE NEMOURS AND COMPANY will award six post-doctorate fellowships for research in organic chemistry and twenty post-graduate fellowships for research in the field of chemistry for the academic year 1940–41, an increase of two post-graduate awards during the coming academic year. The post-doctorate fellowships are for $2,000 each, and the post-graduate fellowships are for $750 each. Fellowships in advanced work in chemistry were established in 1918. The fellowships are not restricted to subjects connected with the company's products, but may be in any chemical research deemed appropriate by the university. The university also selects the beneficiary.

THE object of the du Pont Fellowship Plan is to promote the advancement of science and to cooperate with the educational institutions in their efforts to carry on advanced research work. The institutions to which awards will be made are: to the University of California, the University of Chicago, Columbia University, Cornell University, Harvard University, the University of Illinois, the Johns Hopkins University, the Massachusetts Institute of Technology, the University of Michigan, the University of Minnesota, Northwestern University, the Ohio State University, Pennsylvania State College, the University of Pennsylvania, Princeton University, Purdue University, Stanford University, the University of Virginia, the University of Wisconsin and Yale University.

THE American Institute of Electrical Engineers announces that the Westinghouse Electric and Manufacturing Company has established a trust fund of $25,000 to provide graduate fellowships in electrical engineering as a memorial to Charles LeGeyt Fortescue "in recognition of his valuable contributions to the electric power industry, whose outstanding achievements were his development of symmetrical coordinates, his work on transformer design, and his theories of lightning behavior." Beginning in 1940 the fellowship committee will select annually the "most promising candidates" to receive the Fortescue awards, which provide a minimum allowance of $500 each. The committee is also empowered to grant additional allowances. The 1940 awards will be made before April 1. Professor D. F. Miner, of the Carnegie Institute of Technology, is secretary of the committee.

A GIFT of $250,000 has been made by Edward S. Harkness toward a fund of $2,967,000 being raised for a new twelve-story building for Roosevelt Hospital, New York City. The gift is conditional upon the raising of the remainder of the fund by June 1, 1940. Including the Harkness gift, the sum of $1,034,093 has been subscribed.

Industrial and Engineering Chemistry reports that the Committee of the American Chemical Society on Recommendations for Awards from the Herman Frasch Foundation, Pittsburgh, appointed at the request of the United States Trust Company, met recently to consider requests for grants. The members of the committee are C. A. Browne, *chairman;* Roger Adams, Thorne M. Carpenter, W. H. MacIntire and H. B. Vickery. It was unanimously voted to make the following recommendations with reference to allotments of funds from the foundation for the next five-year period beginning on January 1. (1) Nine thousand dollars to be allotted annually to the Department of Agriculture of the University of Minnesota, University Farm, St. Paul, for research on the project entitled "A Comprehensive Study of Sulfur Metabolism of Plants," with the suggestion that this project in its application be made as general as possible so as to include consideration of sulfur-deficient soils in all parts of the United States. (2) Eight thousand dollars to Purdue University, for research on the project entitled "The Composition of Plants and Their Nutritive Quality as Affected by Cultural and Storage Conditions." (3) Eight thousand dollars to the College of Agriculture of Rutgers University, for research on the project entitled "The Role of Grass and Legume Silages in the Feeding of Dairy Animals."

DR. F. F. BARNES, the geologist of the Alaska Railroad, has recently reported in Washington for service in the office of the Alaskan Branch of the Geological Survey, where he will be afforded facilities for continuing his study of the data collected in Alaska during the past field season. The field studies were made in connection with the considered change in the line of the Alaska Railroad near the head of Turnagain Arm, Kenai Peninsula. The new route would traverse the

narrow, but mountainous neck of land that ties Kenai Peninsula to the mainland and would have its deep water terminus on Passage Canal, an arm of Prince William Sound. The geologic investigation involved examination of the character and structure of the bedrock of the ridges through which it would be necessary to drive tunnels, one of which would be approximately 13,000 feet long; study of the conditions at the near-by glaciers which might jeopardize the project by advances or destruction of drainage; and observation of any other features that might be helpful in the selection of a route so as to avoid snowslides, springs and unstable ground.

A METEOROLOGICAL observatory is being built by the Soviet authorities on Kazbek, one of the highest mountains of the Caucasian range. Mount Kazbek is 16,546 feet high, and the observatory is being built above the snow line at an altitude of 13,125 feet.

DISCUSSION

THE DISTRIBUTION OF POLIOMYELITIS IN LOUISIANA

DURING the ten-year period ending January 1, 1939, there were reported to the State Department of Health from the 64 parishes of Louisiana 676 cases of poliomyelitis, nearly all of which were paralytic. Through the cooperation of parish public health units and other interested physicians, the exact residence of each patient at the time of the onset of the disease was plotted on large, detailed parish maps furnished by the Departments of Agriculture and Economics of Louisiana State University. It was thus possible to circumvent the custom of rural residents of giving the nearest town as the home address.

The population of all incorporated communities, wards and parishes in Louisiana was obtained from the fifteenth United States Census Reports (1930). The population of unincorporated communities was obtained from a commercial atlas, and was corrected, whenever this was possible, by data in the possession of the State Department of Health.

Rural areas, when interpreted as unincorporated communities of 0–99 inhabitants, and small urban communities of 5,000–49,999 inhabitants, had the same low incidence of poliomyelitis, 32.1 and 30.6 per 100,000 population, respectively, the two rates not being statistically different. The incidence in the only two large cities of Louisiana corresponded to the incidence of the disease in the rural and small urban communities. Statistically significant preponderances of poliomyelitis, however, were found in incorporated communities of 100–2,999 population, the rates of 68.2 and 92.7 cases per 100,000 population amounting to three times the rate for rural and larger (over 5,000) urban communities. The highest incidence was found in communities of 1,500–1,999 inhabitants.

The preponderance of poliomyelitis in the small towns of Louisiana could not be explained by age, sex or race factors. The only factor which was found to be statistically correlated with the preponderance of poliomyelitis in the small towns was the presence of a water supply system and the absence of an adequate sewage disposal system. A study of the water supply and sewage disposal systems was therefore undertaken in relation to the incidence of poliomyelitis, official data being used.[1]

The 64 incorporated communities in Louisiana which were without water supply and sewerage systems had 12 reported instances of poliomyelitis, or 39.7 cases per 100,000 inhabitants, which approximates the basal rural-urban rate. The 27 incorporated communities with both water supply and sewerage systems had 184 cases, or 26.6 cases per 100,000 inhabitants. The 87 incorporated communities with water supply but without sewerage systems had 101 cases of poliomyelitis among 120,811 inhabitants, a rate of 83.6 cases per 100,000. These values were of statistical significance.

The highest rates of poliomyelitis, 120 cases per 100,000 inhabitants, which were found in communities with water supply but with no sewerage systems, were in those communities in which the average daily water supply was from 50 to 89 gallons per capita. In communities in which the per capita daily water supply was from 90 to 500 gallons but which were without sewerage systems the rate of poliomyelitis for the decade was 39.0 cases per 100,000 inhabitants, or essentially the basal rural-urban rate. These values were of statistical significance.

These data suggest the effect of large amounts of fluid as a dilution factor or as a factor increasing the rate of flow. The studies also suggest the possibility that the epidemicity of poliomyelitis in the past few decades may have been influenced by the growing tendency of communities to liquefy their excreta without making adequate provision for the disposal of the accumulated fluids.

ALBERT E. CASEY
BRANCH J. AYMOND
LOUISIANA STATE UNIVERSITY
SCHOOL OF MEDICINE AND
LOUISIANA STATE BOARD OF HEALTH

[1] J. H. O'Neill, "Louisiana Water and Sewerage Systems," Publication of the Louisiana State Board of Health, 1938, New Orleans.

A THEORY OF PROTEIN METABOLISM: THE TRANSFORMATION OF PROTEINS

THE current view of protein catabolism is that proteins are hydrolyzed to their constituent amino acids, and these, in turn, are deaminized and the carbon-containing residues are then oxidized or converted into other substances. The particular reaction involved depends on the chemical nature of the amino acid under consideration. It is not the purpose of the present article to deny that some breakdown of proteins may occur in this manner. It is, however, our object to point out that this is not the only possible way whereby proteins may be catabolized. Likewise, although it is possible for the animal organism to synthesize tissue proteins from the amino acids that enter the circulation, it appears to us that synthesis of proteins can take place in the body by the transformation of existing proteins into others without first being broken down to amino acids.

Proteins consist of amino acids that are chemically bound by means of peptide linkages. The side groups are generally free. Among these are the guanidino group of arginine, the hydroxyphenyl group of tyrosine, the phenyl group of phenylalanine, the imidazole ring of histidine, the indole ring of tryptophane, the ε-amino group of lysine, the methylthiol group of methionine, the pyrrolidine ring of proline, the hydroxypyrrolidine ring of hydroxyproline, the carboxyl or acid amide groups of the dicarboxylic amino acids, the methyl group of alanine, etc. Special chemical tests for many of these groups have been devised.

In vitro it is easy to introduce acetyl groups, nitro groups or iodine, etc., into proteins that possess the necessary groups or rings. In fact, it has recently been shown that under appropriate conditions addition of iodine to a number of proteins leads to the appearance of thyroxine in these molecules.[1] Thyroxine is a dispensable amino acid. This is also true of diiodotyrosine. These amino acids are present in proteins of the thyroid gland.[2] Synthesis of the iodine-containing amino acids must then take place *in vivo*. It is not illogical, in view of the *in vitro* experiments, to conclude that thyroglobulin and other iodine-containing proteins are synthesized from proteins that are present in the body rather than built up *de novo* from the appropriate amino acids after synthesis of thyroxine or diiodotyrosine. The latter possibility is not wholly excluded, however, and it may even be possible that the synthesis of the iodine-containing proteins follows both reactions.

Evidence is at hand which shows quite definitely that urea may be formed from proteins by treating them with arginase.[3] It has not yet been found possible, in most instances, to convert all the guanidino groups of proteins into urea in this manner. Krebs and Henseleit[4] report that they were unable to obtain urea from liver slices by the action of arginase. It is quite possible that the optimum conditions for the action of arginase on proteins have not yet been found. The fact that some urea was obtained is significant. The guanidino groups that participated in the reaction have been changed into the δ-amino group of ornithine and thus, by enzymic means, one protein has been converted into another. There is no experimental evidence at hand to indicate that the ornithine-containing protein may be reconverted into the original arginine-containing protein, but this possibility is not excluded. It may perhaps be necessary to postulate such a cycle in the body, especially in view of the fact that, from a quantitative standpoint, it has not been shown that a sufficient amount of free arginine is present in the liver to account for the comparatively large amounts of urea synthesized daily. On the other hand, there is no doubt that there is an ample amount of "potential" arginine in liver proteins.

Tarver and Schmidt[5] have recently advanced the hypothesis that a necessary condition for the conversion of methionine to cystine is that the amino and probably also the carboxyl group of methionine be not free. The attack is then on the distal end of the methionine molecule. The conversion of methionine to cystine evidently takes place when the methionine is contained in a peptide or a protein or both. If the conversion takes place in the protein molecule, then from a methionine-containing protein a cystine-containing protein is obtained, and this is another instance of the transformation of one protein into another.

Since cystine is a dispensable amino acid, it is not unreasonable to conceive that the cystine-containing proteins of animals that were maintained on a cystine-free diet, but did receive methionine, at one time contained only the latter amino acid. Some of the methylthiol groups were subsequently converted to the sulfhydryl groups of cysteine or the dithio groups of cystine.

In fact, the chemical changes that take place in pro-

[1] W. Ludwig and P. v. Mutzenbacher, *Zeits. physiol. Chem.*, 258: 195, 1939.

[2] G. L. Foster, *Jour. Biol. Chem.*, 83: 345, 1929; W. T. Salter and O. H. Pearson, *Jour. Biol. Chem.*, 112: 579, 1935–36.

[3] K. Felix and H. Schneider, *Zeits. physiol. Chem.*, 255: 132, 1938; I. Kraus-Ragins, *Jour. Biol. Chem.*, 123: 761, 1938.

[4] H. A. Krebs and K. Henseleit, *Zeits. physiol. Chem.*, 210: 60, 1932. See also, R. Schoenheimer, S. Ratner and D. Rittenberg, *Jour. Biol. Chem.*, 130: 703, 1939.

[5] H. Tarver and C. L. A. Schmidt, *Jour. Biol. Chem.*, 130: 67, 1939.

tein molecules during denaturation are indicative that transformation of one protein into another takes place without the intervening stage of amino acids.

Recent evidence points to the likelihood that some breakdown of fatty acids occurs by ω-oxidation.[6] It is not inconceivable that the straight side chains of amino acids in the protein molecule may be similarly oxidized.

Indole is easily oxidized, and it is well known that, unless special precautions are taken, tryptophane, when wet or in solution, turns brown on exposure to air. This is also true of some proteins under appropriate conditions. It is difficult to conceive that a necessary condition for the breakdown of the indole ring of tryptophane is that the amino acid be in the free state and not combined in peptides or proteins.

The point that we desire to emphasize, and to which careful consideration should be given in future studies dealing with protein metabolism, is that it may be quite possible that some transformation or breakdown of the free groups in proteins occurs before hydrolysis of the peptide linkages. By such changes one type of protein may be transformed into another. From a thermodynamic view-point such a reaction is probably more efficient than one that requires hydrolysis to amino acids and resynthesis from the selected amino acids.

Finally, it does not appear to us impossible that the immune bodies that are commonly found in the globulin fraction of blood serum are not synthesized *de novo* but by modification of existing globulins. The upset of the normal albumin-globulin ratio by the injection of non-antigenic substances into animals[7] may possibly be another example of the transformation of proteins by slight modification rather than *de novo* synthesis from amino acids.

Our visualization of protein anabolism and catabolism is that not only free amino acids are concerned in the reactions, but also peptides and proteins. It is admitted that experimental evidence in support of the latter concept is still meager. However, but little thought has been given to this idea, and it is the purpose of this article to stimulate interest in this field so that eventually we may have a thorough and adequate knowledge of protein metabolism.

CARL L. A. SCHMIDT
FRANK WORTHINGTON ALLEN
HAROLD TARVER

DIVISION OF BIOCHEMISTRY,
UNIVERSITY OF CALIFORNIA
MEDICAL SCHOOL, BERKELEY

P. E. Verkade and J. van der Lee, *Biochem. Jour.*, 28: 1934. See also, M. Jowett and J. H. Quastel, *Biochem. Jour.*, 29: 2143, 1935.

E. S. Schmidt and C. L. A. Schmidt, *Jour. Immunol.*, 2: 343, 1917.

THE TREATMENT OF EXTREME CASES OF "SNIFFLES" IN THE RAT WITH SULFAPYRIDINE

SULFANILAMIDE, though very helpful as a counter-irritant in the lighter attacks of "sniffles" in the laboratory rat, apparently does little more than slow the progress of the disease in cases where the infection is more extreme and deep-seated.

In such cases we have employed sulfapyridine with much success. The dosage used is 1 mg per gram body weight of rat mixed with a small quantity of food. If the animal will not eat, a 2 cc concentrated solution of *sulfanilamide* injected abdominally gives the animal a respite from the disease which is accompanied by a return of appetite. *Sulfapyridine,* in the meantime, is mixed with a small quantity of food, preferably cow's milk (18 per cent. butter fat). Ingestion of the sulfapyridine obviates further use of sulfanilamide.

FRED Y. BILLINGSLEA
WESTERN RESERVE UNIVERSITY

SOVIET COSMOLOGY

THE following is a translation of resolutions that were adopted by the section of astronomy of the Academy of Sciences of the U.S.S.R. in December, 1938, and printed in Volume 16, No. 2, of the *Astronomical Journal of the Soviet Union:*

Having heard the papers of Eigenson, Zelmanoff, Bogorodsky and Krat, the meeting adopts the following:

1. Modern bourgeois cosmogony is in a state of deep ideological confusion resulting from its refusal to accept the only true dialectic-materialistic concept, namely, the infinity of the universe with respect to space as well as time.

2. The hostile work of the agents of Fascism, who at one time managed to penetrate to leading positions in certain astronomical and other institutions as well as in the press, has led to revolting propaganda of counter-revolutionary bourgeois ideology in the literature.

3. The few existing Soviet materialistic works on problems of cosmology have remained in isolation and have been suppressed by the enemies of the people, until recently.

4. Wide circles interested in science have been taught, at best, only in the spirit of indifference toward the ideological aspect of the current bourgeois cosmologic theories. . . .

5. The exposé of the enemies of the Soviet people makes necessary the development of a new Soviet materialistic cosmology. Already there are a few pioneer Soviet specialists in this subject. . . .

8. It is deemed necessary that Soviet science should enter the international scientific arena carrying concrete achievements in cosmologic theories on the basis of our philosophic methodology.

ASTRONOMER

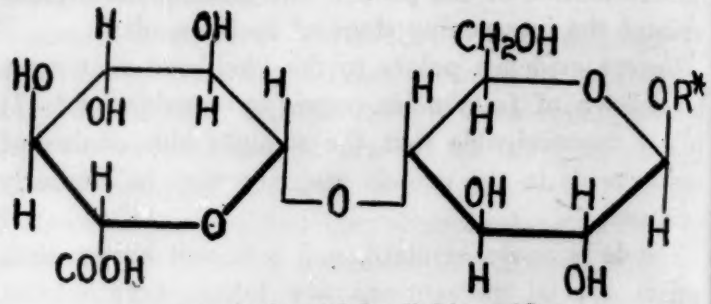
SPECIAL ARTICLES

IMMUNITY TO EXPERIMENTAL PNEUMOCOCCAL INFECTION WITH AN ARTIFICIAL ANTIGEN CONTAINING A SACCHARIDE OF SYNTHETIC ORIGIN

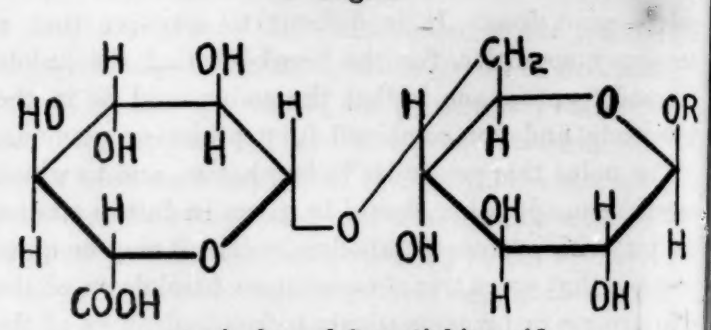
EXPERIMENTAL investigations on the chemical and immunological properties of bacterial polysaccharides and artificial antigens containing simple saccharides of known chemical constitution have revealed many of the factors which govern the immunological specificity of encapsulated microorganisms. With the gradual accumulation of this knowledge we have come to the belief that it should be possible to incite antibacterial immunity in experimental animals with artificially compounded antigens containing immuno-specific groups of synthetic origin rather than with antigenically complex bacterial cells as they naturally occur.

Recently we have shown that an artificial antigen containing the azo benzyl glycoside of cellobiuronic acid evokes in rabbits antibodies which agglutinate Type III pneumococci and confer passive immunity on mice against infection with virulent pneumococci Types II, III and VIII.[1] Cellobiuronic acid, obtained from the acid hydrolysis products of the specific polysaccharide of Type III pneumococcus[2] is constituted from molecules of glucose and glucuronic acid linked in β-glucuronosidic union on the fourth carbon atom of the hexose. Several years ago we described the synthesis of an isomeric aldobionic acid, gentiobiuronic acid or 6-β-glucuronosido-glucose.[3] We have now succeeded in preparing the acetohalogen derivative from heptaacetyl gentiobiuronic acid methyl ester, and from this the corresponding amino benzyl aldobionide has been obtained.[4] An artificial antigen has in turn been prepared by combining the diazonium salt of the aldobionide with horse serum globulin. We have at hand, therefore, two antigens, one containing the azo benzyl glycoside of the naturally occurring aldobionic acid 4-β-glucuronosido-glucose, the other, the corresponding glycoside of the synthetic aldobionic acid, 6-β-glucuronosido glucose. The structural relationship of these two aldobionides is represented by the following graphic formulae.

Since the two saccharides differ only in the position but not the configuration of the glucuronosidic linkage, any differences in their immunological properties can be directly correlated with these differences in chemical constitution. When rabbits are injected with the antigens containing the azo benzyl glycosides of these two



p-aminobenzyl β-cellobiuronide
* R = $NH_2C_6H_4CH_2$–
Fig. I



p-aminobenzyl β-gentiobiuronide
Fig. II

aldobionic acids the antibodies evoked are in each instance specifically directed toward the saccharides in question. The specificity of the antibodies is best demonstrated by the fact that the homologous precipitation reactions are in each instance inhibited only by the homologous and not by the heterologous amino benzyl aldobionide.

As previously pointed out, the antiserum to the cellobiuronic acid antigen agglutinates Type III pneumococci and confers passive protection on mice against infection with virulent pneumococci of Types III and VIII. The serum of rabbits injected with the gentiobiuronic acid antigen, on the other hand, exhibits none of these phenomena. It is apparent, therefore, that the position of the glucuronosidic linkage determines the immunological specificity of antigens containing these acids in so far as their capacity to evoke antibacterial immunity to Types III, VIII pneumococci is concerned.

In addition to conferring protection on mice against Types III and VIII pneumococcal infection, the antiserum to the cellobiuronic acid antigen also confers immunity against infection with Type II pneumococci. The antiserum evoked by the antigen containing the synthetic gentiobiuronic acid, although failing to protect mice against infection with either Types III or VIII pneumococci, does afford passive immunity against infection with as much as 100,000 minimal lethal doses of Type II organisms. That this is a property peculiar to the two uronic acid antigens is evidenced by the fact that antigens containing the disaccharides cellobiose and gentiobiose evoked antibodies which show no protective action against Type II pneumococcal infection in mice. In view of the

[1] W. F. Goebel, *Jour. Exp. Med.*, 69: 353, 1939.

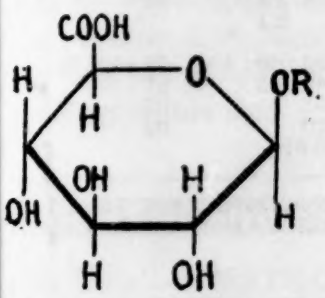
[2] M. Heidelberger and W. F. Goebel, *Jour. Biol. Chem.*, 74: 613, 1927; R. D. Hotchkiss and W. F. Goebel, *Jour. Biol. Chem.*, 121: 195, 1937.

[3] R. D. Hotchkiss and W. F. Goebel, *Jour. Biol. Chem.*, 115: 285, 1936.

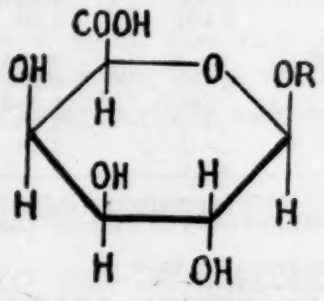
[4] The synthesis of these derivatives will be described in a later communication.

experiments one is faced with the necessity of explaining a new and peculiar fact, namely, the reason underlying the protective action exhibited by the antisera elicited by antigens containing isomeric aldobionic acids against infection with the same microorganism. It is possible to demonstrate experimentally that the protective action of cellobiuronic and gentiobiuronic acid antisera can be attributed to the antibody evoked by the glucuronic acid component common to the two aldobionic acid antigens.

Two artificial antigens, one containing the azo benzyl glycoside of glucuronic acid, the other that of galacturonic acid, have been prepared. The amino benzyl glycosides of these two uronic acids differ only in the configuration of the fourth carbon atom where the position of the H and OH groups is interchanged, as can be seen in Figs. III and IV.



p-aminobenzyl glucoronide
R = $NH_2C_6H_4CH_2$–
Fig. III



p-aminobenzyl galacturonide
Fig. IV

This alteration in constitution has a profound influence in determining the serological specificity of these antigens, as was shown in a study from this laboratory several years ago.[5] That this alteration in configuration of but one carbon atom will determine the capacity of the hexuronic acid antigens to evoke antibacterial immunity is likewise evident, for it has now been found that the antisera of rabbits injected with the glucuronic acid antigen protect mice against infection with 100,000 minimal lethal doses of Type II pneumococci (though not to Types III and VIII), whereas the antiserum to the galacturonic acid antigen is devoid of any protective action whatsoever.

In view of this experimental evidence it is justifiable to conclude, first, that passive immunity to Types III and VIII pneumococcal infection can be conferred on mice by the sera of rabbits immunized with an artificial antigen containing an aldobionic acid having an exact and appropriate configuration; second, that it is possible to confer passive immunity to Type II pneumococcal infection on mice with the sera of rabbits injected with artificial antigens containing saccharides of synthetic origin. The immunity conferred appears to be attributable to an antibody directed toward glucuronic acid. If the molecular configuration of but one of the carbon atoms of the hexuronic acid constituent of the antigen is altered, its capacity to evoke immunity to Type II pneumococcal infection is lost.

WALTHER F. GOEBEL
THE HOSPITAL OF THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK

[5] W. F. Goebel and R. D. Hotchkiss, *Jour. Exp. Med.*, 66: 191, 1937.

THE DETERMINATION OF THE TOTAL D-AMINO ACID CONTENT OF HUMAN TUMORS AND NORMAL TISSUES BY MEANS OF D-AMINO ACID OXIDASE

THE reports in recent months by Kögl and co-workers[1] of the characteristic occurrence of amino acids of unnatural configuration in malignant tumors in man and rabbit have been followed by several papers[2] tending both to confirm and to discredit this claim of obviously profound and immediate interest for the biochemistry of tumors. Most of the reports concerned make evident certain difficulties involved in establishing or rejecting such a conclusion on the basis of isolation procedures. We have, therefore, utilized the specific *d*-amino acid oxidase preparation of Krebs[3] for the determination of the *total d*-amino acid content of hydrolysates of a fairly representative variety of benign and malignant human tumors, normal human tissues and some proteins of especial interest: the urinary Bence-Jones protein, because of its close correlation with multiple myeloma in man; insulin as a hormone; and gliadin because of its very high (45 per cent.) glutamic acid content. The hydrolyses were conducted essentially as described by Kögl, in initially 25 to 35 per cent. HCl for 7 to 15 hours, usually with 10 gm acetone-dried tissue, or occasionally directly with fresh tissue. After elimination of the excess HCl, and appropriate neutralization and dilution, the *d*-amino and total nitrogen contents of aliquot portions were determined as reported in Table 1, which gives all data of this nature obtained by us to date.

All biologically significant *d*-α-amino acids are oxidatively deaminated by the Krebs enzyme, but at widely varying rates, so that to obtain reasonably complete oxidation of the slowly reacting *d*-amino acids the experiments were run for 20 hours with concentrated enzyme preparations stabilized by gum ghatti, and with thymol crystals added as antiseptic. As indicated in the table, 70 to 80 per cent. of the *d*-glutamic acid, the slowest reacting amino acid (*cf.* Krebs, 3,

[1] F. Kögl and H. Erxleben, *Verh. Kon. Ned. Akad. Wet.*, II, 38: 1, 1939; *Z. physiol. Chem.*, 258: 57, 1939, 261: 154, 1939; *Naturwissensch.*, 27: 486, 1939; *Nature*, 144: 111, 1939; F. Kögl, *Klin. Wochensch.*, 18: 801, 1939; *Z. f. Krebsforsch.*, 49: 291, 1939; F. Kögl, H. Erxleben and A. M. Akkerman, *Z. physiol. Chem.*, 261: 141, 1939.

[2] (Confirmatory) L. E. Arnow and J. C. Opsahl, SCIENCE, 90: 257, 1939; J. White and F. R. White, *Jour. Biol. Chem.*, 130: 435, 1939. (Non-confirmatory) A. C. Chibnall, M. W. Rees, G. R. Tristam, E. F. Williams and E. Boyland, *Nature*, 144: 71, 1939; S. Graff, *Jour. Biol. Chem.*, 130: 13, 1939; E. Chargaff, *Jour. Biol. Chem.*, 130: 29, 1939; C. Dittmar, *Z. f. Krebsforsch.*, 49: 397, 444, 1939.

[3] H. A. Krebs, *Biochem. Jour.*, 29: 1620, 1935.

TABLE 1

THE MAXIMUM *d* AMINO ACID CONTENT OF HYDROLYSATES OF HUMAN TUMORS, TISSUES AND PROTEINS DETERMINED BY MEANS OF *d*-*a*-AMINO ACID OXIDASE

Column 1	2	3	4	5	6	7
Material	Source	cmm O_2 consumed (exp. obs.[a])	mg *d*-N calc.[b] per cc[c]	mg total N per cc[c]	Per cent. *d*-N of total N	(Per cent. recovery of added *d*-N)
Protein	E. Bence-Jones	19 ; 20	0.041	7.13	0.6	
	M. Insulin	55	0.074	4.76	1.5	
	L. Gliadin	35	0.073	5.71	1.3	70 (*d*-glut-N)[d]
Normal Tissue	B. Liver	58	0.120	5.04	2.4	79 "
	H. Lung	28 ; 27	0.058	5.14	1.1	
	Y. Breast	66 ; 67	0.014	.78	1.8	
	P. Spleen	97	0.244	11.66	2.1	
Benign Tumor	Z. Ovary (fibroma)	64	0.016	.90	1.8	
Sarcoma	J. Back (fascial and liposarcoma)	36	0.076	3.42	2.2	82 "
Carcinoma	D. Liver (secondary from thyroid)	37	0.080	4.66	1.7	71 "
	N. Liver (secondary from rectum)	137	0.226	14.61	1.5	
	F. Ovary (secondary from uterus)	28 ; 29	0.060	5.20	1.2	
	K. Breast (infiltrating duct, gr. 4)	27	0.056	4.67	1.2	87 "
	X. Breast " " gr. 2)	47 ; 45	0.096	2.62	3.7	
Miscellaneous Malignant	G. Kidney (Wilms' adenomyosarcoma)	22 ; 25	0.049	5.12	1.0	
	I. Abdomen (secondary teratoma testis, mainly carcinoma)	31	0.065	4.64	1.4	80 "
Leukemia	O. Spleen (myelogenous, acute)	84	0.104	4.89	2.1	
d,l-glutamic acid		79 ; 89 ; 89		0.280	36 ; 40 ; 40	71 ; 80 ; 80
d,l-alanine		109 ; 119		0.280	48 ; 53	97 ; 106
d-phenylaminobutyric acid		272		0.350	97	97
amino acid mixture[e] approximating casein		211		1.30	20	92
l-glutamic acid		6		1.40	(0.6)	

F,J,K,X,Y,Z, Memorial Hospital Nos. 1968, 1471, 2062, 1255, 1287 (operative); B,D,G,H,I, Nos. 1496, 1496, 1699, 1496, 2052 (autopsy). N,O,P, New York Hospital Nos. 9759, 9762, 9764 (autopsy). Normal tissues B,H,Y, from tumor cases; P from non-tumor case.

[a] With samples of diluted neutralized hydrolysate, varying from 0.6 to 6 cc.

[b] Cmm O_2 = 0.00125 mg N ($RCHNH_2COOH + \frac{1}{2} O_2 = RCOCOOH + NH_3$).

[c] Per cc of neutralized hydrolysate diluted variously 1/10, 1/25, or 1/100.

[d] "112" cmm *d*-glutamic acid (as *d*-*l*-) added to replicate, diluted hydrolysate aliquots of B,D,I,J,K,L, immediately before analysis by d-amino acid oxidase; recovery calculated from difference between replicates ± d-glutamic-N addition.

[e] 17 amino acids[4] containing 8 in *d*-*l*-form (alanine, valine, leucine, isoleucine, phenyl-alanine, serine, lysine and threonine), and with 22 per cent. of the total amino-N in the *d* form.

Table XII), was recovered by the method and reaction period employed (100 per cent. of *d*-alanine or *d*-phenylaminobutyric acid, but a negligible quantity of *l*-glutamic acid). Seventy to 80 per cent. of *d*-glutamic acid was likewise analytically recovered when added to various samples before hydrolysis (sample D) or after hydrolysis (samples B, D, I, J, K, L, Column 7, and sample N[5]). The values in Column 3 have been corrected for any O_2 consumption by the enzyme preparation without substrate. Ammonia estimations were carried out in a number of cases in order to ascertain that the O_2 consumption was due mainly to *d*-amino acid oxidation. Values of equivalent NH_3 as much as 25 to 50 per cent. less than the O_2 consumption were sometimes obtained, suggesting concomitant oxidation of a certain amount of non-nitrogenous material; on the other hand, the NH_3 determinations were definitely less accurate than those of O_2 consumption, owing to the relatively large blank values for NH_3 in the hydrolysates themselves. The non-specific oxidation certainly more than counterbalanced the slight incompleteness of reaction caused by the more slowly reacting amino acid. The *d*-amino acid-N values in Column 6 are to be regarded, therefore, essentially as *maximum values*, perhaps 25 to 50 per cent. too high in some cases. For the question of malignancy specificity at issue, however, the two possible errors indicated are of little moment, since we are mainly concerned here with the order of magnitude of *d*-amino acid-N. It must be considered, furthermore, that the values in Column 6 include the amino acids already generally known to racemize partially on hydrolysis (serine, proline, cystine, etc.). Finally, it is to be observed that the materials reported in Table 1 are equivalent in number and variety to those reported by Kögl, namely, 7 normal tissues, 3 normal tissues from tumor-bearing animals, 4 benign tumors and 12 malignant tumors.[1] We would likewise emphasize that the findings in our various types of control experiments lend great confidence as to the efficacy and adequacy of the simple, direct and specific enzymatic method of analysis employed, in contrast to the isolation procedures of Kögl involving incomplete and very possibly unrepresentative recoveries of enantiomorphs.

[4] V. du Vigneaud, J. P. Chandler, A. W. Moyer and D. M. Keppel, *Jour. Biol. Chem.*, 131: 57, 1939.

[5] Not added immediately before manometric analysis, as with samples B, D, I, J, K, L, but to strongly acidified, aliquot sample N hydrolysate mother liquor 39 days before eventual dilution and analysis, during which period two crops of practically pure *l*(+)-glutamic acid hydrochloride were removed (410 mg from initial 6.3 gm dried liver tumor, or 5.3 per cent. *l*-glutamic acid). The isolated second crop (260 mg) was shown by means of *d*-amino acid oxidase to contain no *d*-amino acid.

CONCLUSION

The uniformity and low order of *d*-amino ac

nitrogen observed in the variety of hydrolysates examined, whether from benign or malignant[6] tumors, normal tissues or proteins (Column 6), shows that malignancy is, *as a generality,* not specifically characterized by the presence of amino acids of unnatural (*d*-) configuration. Whatever interest certain of Kögl's data may retain for general biochemistry, the main contention concerning malignancy specificity is, for the cancer field, evidently no longer tenable.

Further experimental details and discussion of our work will be forthcoming, together with accompanying data on glutamic acid isolations from some of the more interesting hydrolysates. Following the suggestion of Professor du Vigneaud, most of the hydrolyses were carried out in HCl containing heavy water, and experiments to determine the content of deuterium attached to the *alpha* carbon atom will be performed with any *d*-glutamic acid found. It is hoped that this procedure will provide a critical decision as to whether such glutamic acid as may occur partially racemized in the hydrolysates had been formed during the process of hydrolysis.

We are deeply indebted to Dr. C. P. Rhoads, Dr. Fred Stewart, Dr. Frank Foote, Dr. Ruth Snyder and Dr. John Pool, of Memorial Hospital, for large numbers of tumors and tissues identified and kindly placed at our disposal by them; likewise to Dr. Jacob Furth, of the Department of Pathology, Cornell University Medical College and New York Hospital; to Miss Betty Robinson for technical assistance; to the National Advisory Cancer Council, the Jane Coffin Childs Memorial Fund, and the Ella Sachs Plotz Foundation for grants; and, finally, to Professor Vincent du Vigneaud for his counsel.

FRITZ LIPMANN
OTTO K. BEHRENS[7]
ELVIN A. KABIT
DEAN BURK

DEPARTMENTS OF BIOCHEMISTRY AND PATHOLOGY, CORNELL UNIVERSITY MEDICAL COLLEGE; AND NATIONAL CANCER INSTITUTE, U. S. PUBLIC HEALTH SERVICE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE METHOD TO USE IN RECOVERING FECES AT MEASURED INTERVALS

IT is often necessary to collect fecal droppings from test animals at given intervals, and to do this by means of a simple, inexpensive and yet accurate mechanism would facilitate the handling of many physiological problems. This is especially desirable where constant attendance is not possible and a continuous record is desired. Such is the case when measuring the time at which poisons are eliminated from an animal body.

The method, as outlined below, was used to accurately determine the larval life history of *Pieris rapae* (Lepidoptera), and could be used in toxicological investigations on many leaf-feeding insect larvae.

By connecting the hour-hand mechanism of a clock to a thin aluminum disk (a phonograph record may be equally well used, depending upon the chemical requirements desired) supported on a bearing so as to rotate freely, the disk will revolve once in every twelve hours. An insect feeding upon a small leaf suspended above the moving circular sheet will leave, by means of the excrement dropped, a record of its activities. If ingested poisons caused the insect to fall, it would remain on the record as its own marker of the time of collapse. With *Pieris rapae,* the insect fed on a rooted cabbage leaf suspended in a constant temperature compartment over the disk which provided an adequate time-recording mechanism and left its whole history in the form of pellets and cast skins.

Numerous adaptations may be applied. With caged animals such as mice, a funnel placed under wire-floored cages can direct excreta to a series of pockets on the circular sheet, and with a series of removable disks a semi-permanent record is obtained which may later be analyzed. A record of the number of caterpillar pellets may be plotted with time as the abscissa and number of pellets as the ordinate, and the life history with molts can be timed with far less experimental error than is introduced by normal variation. Should it be desirable to run more than twelve hours without attention, a large disk can be used and the speed geared down; or, as was done in one instance, the source of pellets was shifted into another circle by means of an electrical circuit being completed by contact to a point on the disk, so as to act through a relay.

In insects at least, the amount of excreta is proportional to the feeding and may be used to investigate the effect of factors such as light, temperature, humidity, repellents, etc., on the feeding rate. With *Pieris rapae* it was found that (1) the number of pellets excreted, if grouped in hour or two-hour intervals, will show pronounced fluctuations, there being periods of greater or lesser feeding. (2) The length of the non-feeding periods during ecdysis one through four were successively 9, 16, 17 and 29 hours. (3) The feeding gradually builds up to a maximum in each instar and then abruptly ceases in preparation for the molt. (4)

[6] The rather higher value for sample X (3.7 per cent. *d*-N) was not obtained with the other primary breast carcinoma of even more advanced malignancy (sample K, 1.2 per cent. *d*-N).

[7] Lalor Foundation Fellow.

There is an increase in the size and number of pellets with each instar until in the last there is evidence of extremely voracious feeding. The duration of the feeding part of each stage was 30, 50, 60, 70 and 80 hours.

KENTON L. HARRIS

WASHINGTON, D. C.

INDEXING AND FILING SCIENTIFIC PHOTOGRAPHS

RECENTLY the author has had occasion to consider at some length the problem of indexing and filing geological photographs. Inquiry among photographers and professional colleagues has revealed that there is a wide variety of possible systems and that in a surprisingly large number of instances the collections are characterized by little or no system. In the field sciences, particularly geology and geography, some system of filing photographs is absolutely essential. This has been very forcibly brought home here at the University of Maine. The geology department recently received the gift of a considerable number of photographs and negatives of a geologist who died suddenly. Unfortunately, negatives and prints were separate and many of each lost. Localities were impossible to identify except in the few cases where there was a notation on the back of the print, or were identified by personal recognition. The value of the collection, hence, is only a fraction of what it might have been otherwise.

Some photographers use albums for the preservation of prints with sections devoted to various aspects of subject-matter. Negatives of such prints are easily lost or confused. Some use a continuous number system, the individual pictures being numbered in order of acquisition. No mineralogist would think of arranging a mineral collection in any such order, and a photographic collection so indexed or numbered is equally confused.

The following system has been devised here at the University of Maine for our geology collection. Although at present the collection is small, it is planned as the nucleus of a continually growing collection, and the system is elastic enough to take care of any expansion. Our system is, in brief: Prints are mounted on the face of a four-by-six envelope. On the back of each print and envelope is written the exact locality and date, a number and such other data as may be desirable. The proper number is also printed in the upper left-hand corner of the face of the envelope; if a lantern slide of the photograph has been made the number is printed in red, otherwise in black. The corresponding number is also inked onto the negative, and the negative placed in the envelope. Index tabs between the various major divisions are placed in the file, so that the photographs are naturally grouped.

The numbering system used is a decimal system. An example of our practice follows: One of our pictures has the number 8.11–3. The "8" at the left of the decimal indicates glacial work; the first figure "1" at the right of the decimal indicates erosion; the second "1" indicates striae and polished surface; the last figure, "3," indicates that this is the third of such photographs on file. Another of our pictures is 4.112–5. The figure "4" at the left of the decimal point indicates streams; the first figure "1" at the right of the decimal point indicates erosion; the second "1" at the right of the decimal point indicates the stream is in the youthful stage of the erosion cycle; the third figure at the right of the decimal point indicates potholes; the fourth figure individualizes that particular photograph. A supplementary card index may also be of value.

The system can be modified in a number of ways to meet varying requirements. Special collections may be headed by other figures at the left of the decimal. (The figures we are using at the left of the decimal in our general collection correspond to the chapter numbers of a very widely used introductory text-book of geology—but this is merely for convenience in assigning the picture to the general group.)

It is hoped that this note may be of some value, in a suggestive way, to the apparently considerable number who have no very satisfactory way at present of filing and indexing photographs. No claim is made for the originality of this system. Possibly similar systems may be in vogue in many individual instances, although such have not come to the writer's attention.

JOSEPH M. TREFETHEN

UNIVERSITY OF MAINE

BOOKS RECEIVED

HAMILTON, W. J., JR. *American Mammals.* Pp. xii + 434. 92 figures. McGraw-Hill. $3.75.

HIRSCHLAFF, E. *Fluorescence and Phosphorescence.* Pp. vi + 130. 42 figures. Chemical Publishing Co. $1.50.

MELLANBY, HELEN. *Animal Life in Fresh Water.* Pp. viii + 296. 211 figures. Chemical Publishing Co. $3.50.

PORTEVIN, G. *Ce qu'il faut Savoir des Insectes. Vol. II, Coléoptères et Hémiptères.* Pp. 307. 14 plates. 100 figures. Paul Lechevalier, Paris. 40 fr.

REED, C. I., H. C. STRUCK and I. E. STECK. *Vitamin D: Chemistry, Physiology, Pharmacology, Pathology, Experimental and Clinical Investigations.* Pp. xviii + 389. 13 figures. University of Chicago Press. $4.50.

SHEPHERD, WALTER. *Science Marches on.* Pp. 420. 188 figures. 31 plates. Harcourt, Brace. $3.00.

Smithsonian Institution, Annual Report of the Board of Regents, 1938. Pp. xiii + 608. Illustrated. Superintendent of Documents, Washington. $1.50.

SVEDBERG, THE. and K. O. PEDERSEN. *Die Ultrazentrifuge; Theorie, Konstruktion und Ergebnisse.* Pp. xii + 436. 154 figures. Theodor Steinkopff, Dresden. RM 27.75.

Texas Agricultural Experiment Station. Commercial Feeding Stuffs; from September, 1938 to August, 1939. Bulletin No. 578. Pp. 205. *Iodine in Texas Soils. Bulletin No. 579.* Pp. 25. 1 figure. Agricultural and Mechanical College of Texas, College Station.